SPINDLE SERVO UNIT

MAINTENANCE MANUAL (1st Edition)

Pub.No.4018-E (EES4-001-O1) Jan.1995

OKUMA

SAFETY GUIDELINES

The control device described in this manual uses a variety of electric parts and units. Before making connections between these parts and units or connecting the power source, read this manual carefully and strictly observe the following points to avoid accidental injury, malfunction or burning of units, and other trouble.

(1) Before connecting or disconnecting a unit, shut off the power supply completely and discharge the charged parts in the unit. Failure to do this could result in injury due to electric shock, or unit malfunction or burning.

(2) Before connecting the power supply to a unit, check the specifications of the power source. If the source voltage does not match the voltage to be supplied or the polarity is incorrect, units may malfunction or burn.

(3) Connect the inputs and outputs to each unit correctly. Incorrect connection could cause units to malfunction or burn.

(4) Be sure to connect the grounding of each unit, and the P.E. grounding cable, to the electrical cabinet. Failure to do this will result in injury in the event of a leak.

(5) Be sure to connect an overcurrent protection device (breaker or fuse) in the power supply cables. Failure to do this could cause burning of cables or units, or the outbreak of fire, in the event of a short-circuit.

(6) When making the cables to connect the units, select wire sizes that are suitable for the application. Especially in the case of power cables, the selection must be made in accordance with the load current. If the cable capacity is insufficient for the application, the cables will overheat and this may cause them to burn or cause a fire.

(7) The electrical cabinet, operation box, or other enclosure where the units are installed must have a water-proof and dust-proof construction. If it does not, injuries due to electric shock may be caused, and units may malfunction or burn.

(8) Always use the thermostats incorporated in the motors and units to protect these devices. If you do not, the devices may burn or cause fires.

The following warning indications are used in this manual to draw attention to information of particular importance.

: Indicates an imminent hazard which, if not avoided, will result in death or serious injury.

: Indicates unsafe practices which, if not avoided, could result in death or serious injury.

: Indicates unsafe practices which, if not avoided, could result in minor injuries or damage to NC unit or other equipment.

Note: Indicates precautions relating to NC unit operations.

This manual must be kept for future reference.
The contents of the manual are subject to change due to product improvements.

TABLE OF CONTENTS

SECTION 1 OUTLINE

This manual describes the maintenance and inspection procedure for the VACIII drive unit and the VAC motor.

1. CONFIGURATION

VACIII drive unit is the spindle servo driver which controls the spindle speed and spindle angular position accurately. For the input of commands to the VACIII drive unit, digital communication line using the optical fiber cable is used to ensure high reliability as well as to simplify wiring.

The drive unit is selectable from VACIII-D6 unit to VACIII-D22 unit meeting the capacity of the VAC motor to be controlled.

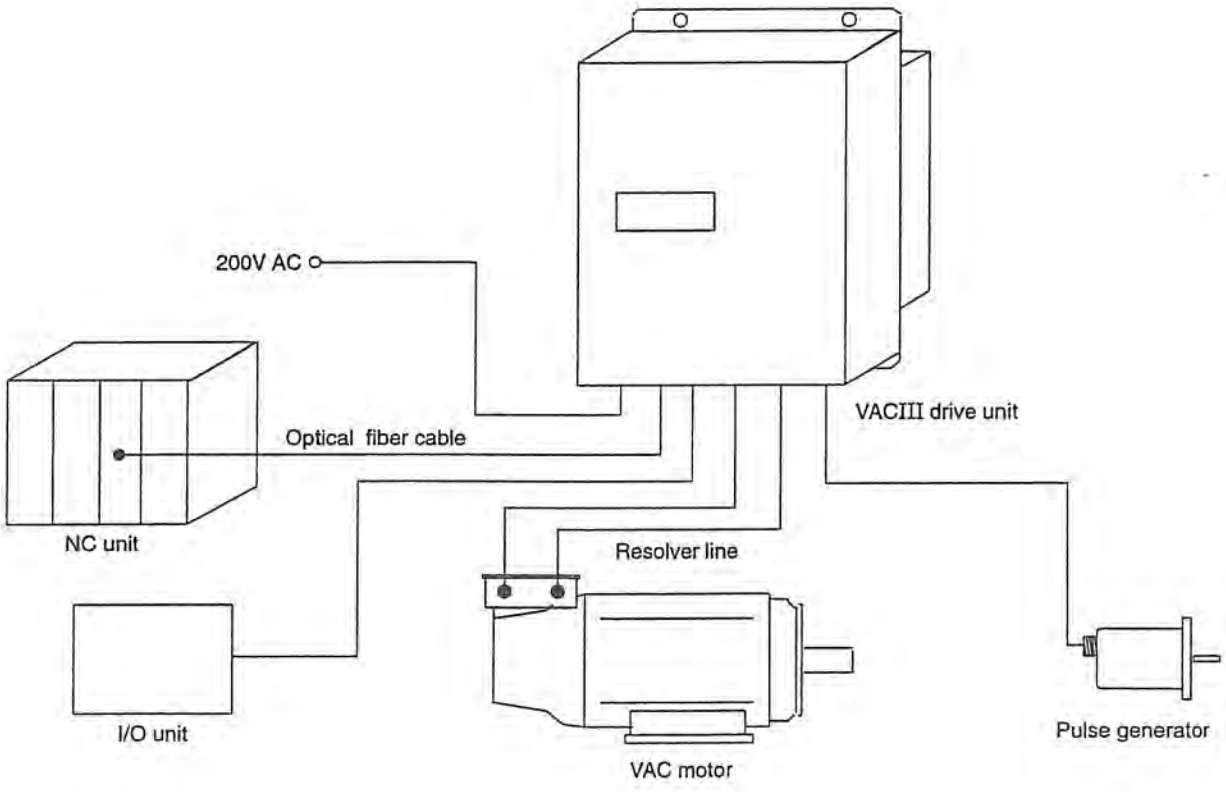
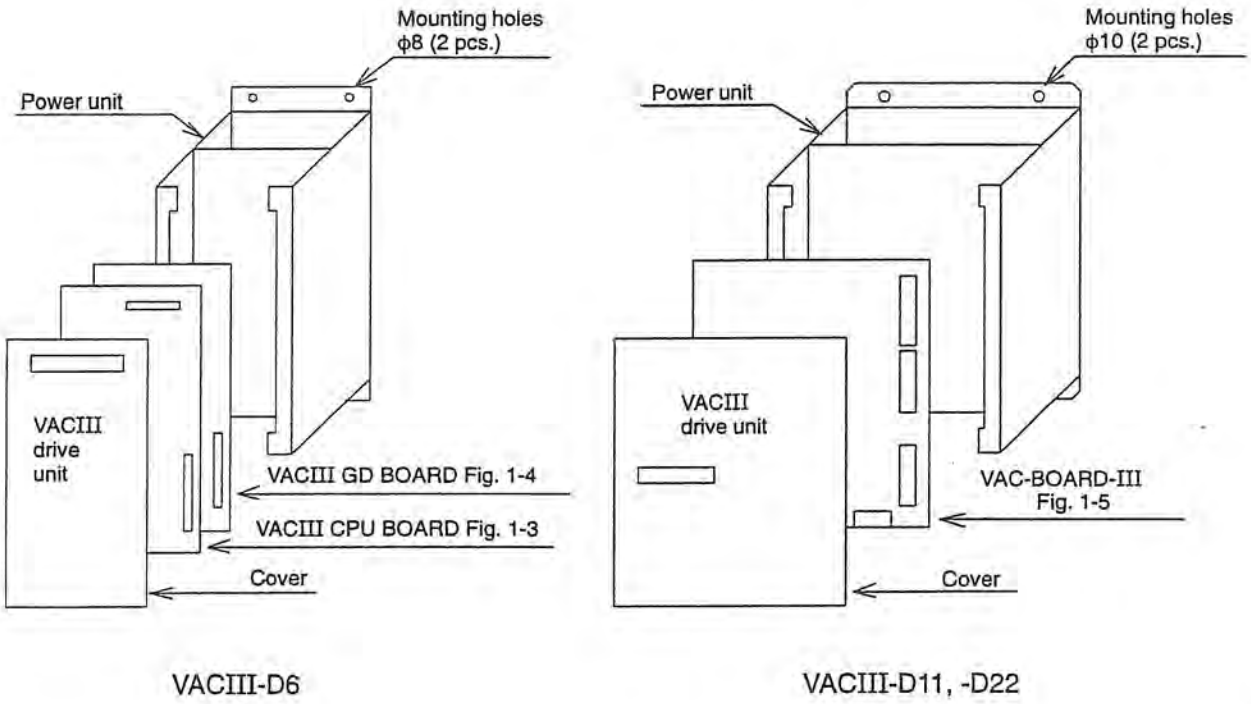


Fig. 1-1 AC Spindle Motor System Configuration

1-1. VACIII Drive Unit

The VACIII-D6 unit is consisted of the VACIII CPU BOARD, VACIII GD BOARD, and power unit D6.

The VACIII-D11 and VACIII-D22 units are consisted of the VAC-BOARD-III and the corresponding power unit (power unit D11 for VACIII-D11 and power unit D22 for VACIII-D22).



VACIII-D6 VACIII-D11, -D22

Fig. 1-2 VACIII-Drive Unit Configuration

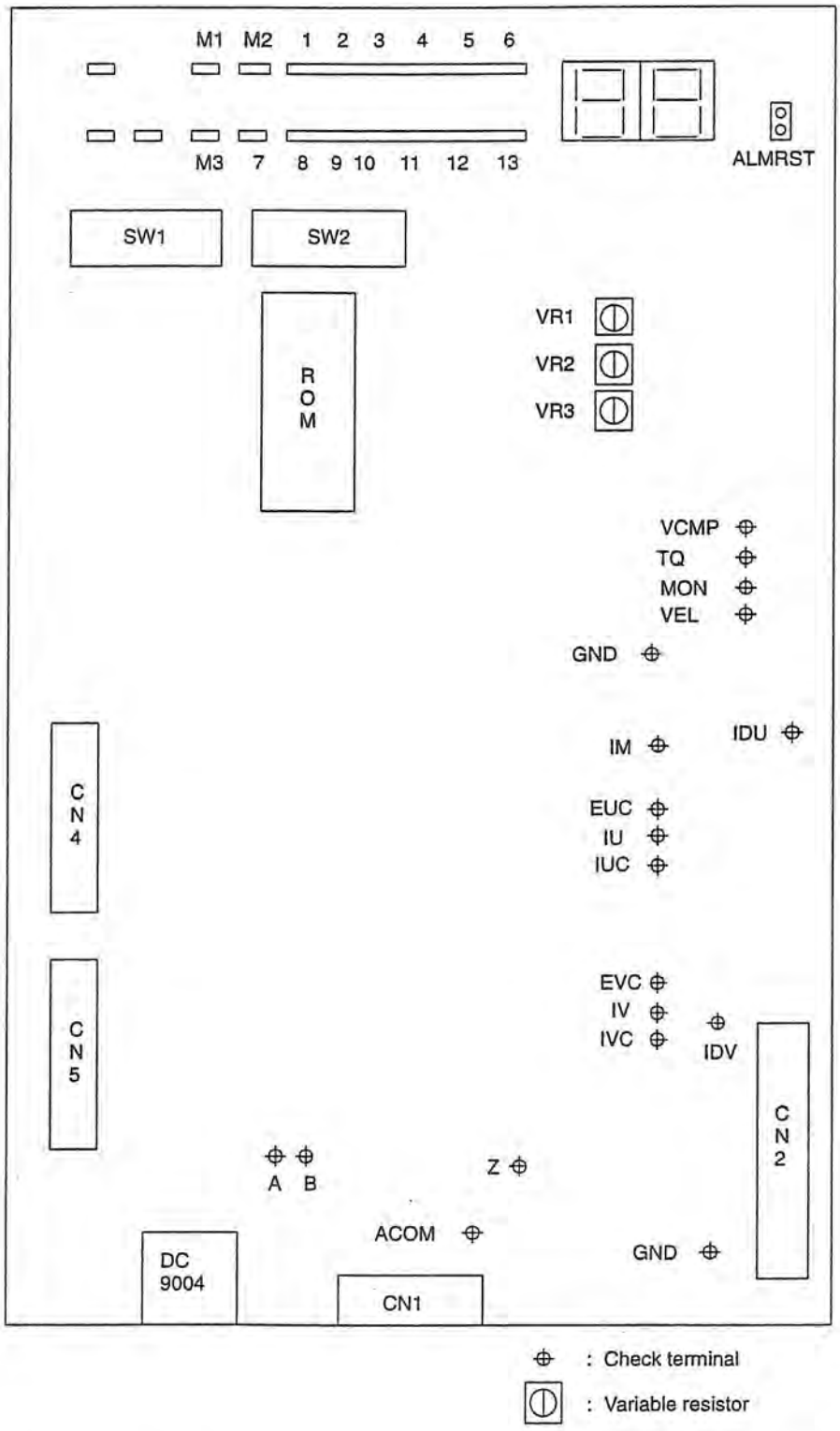


Fig. 1-3 Arrangement of Major Component Parts on VACIII CPU Board for VACIII-D6 Unit

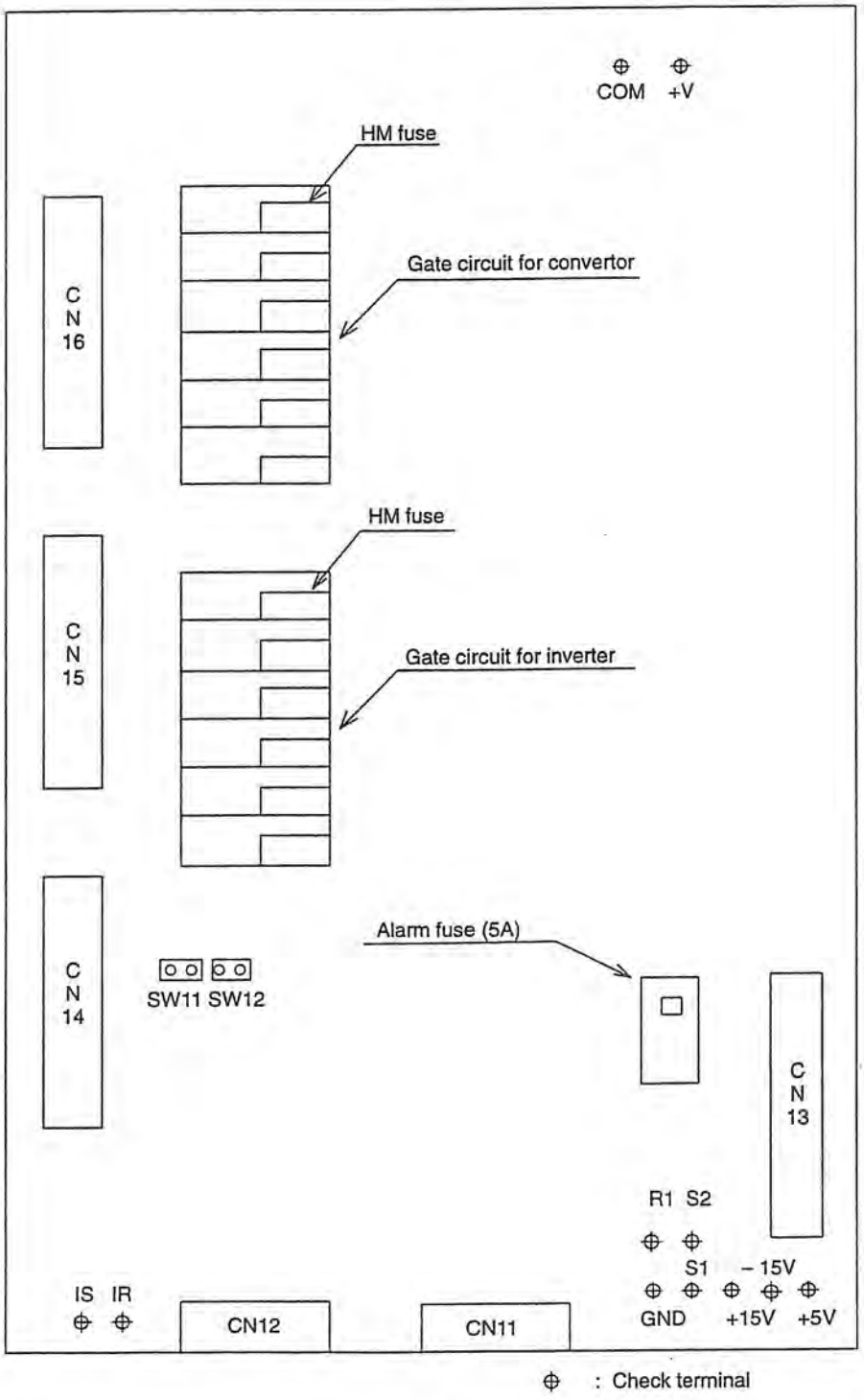


Fig. 1-4 Arrangement of Major Component Parts on VACIII GD Board for VACIII-D6 Unit

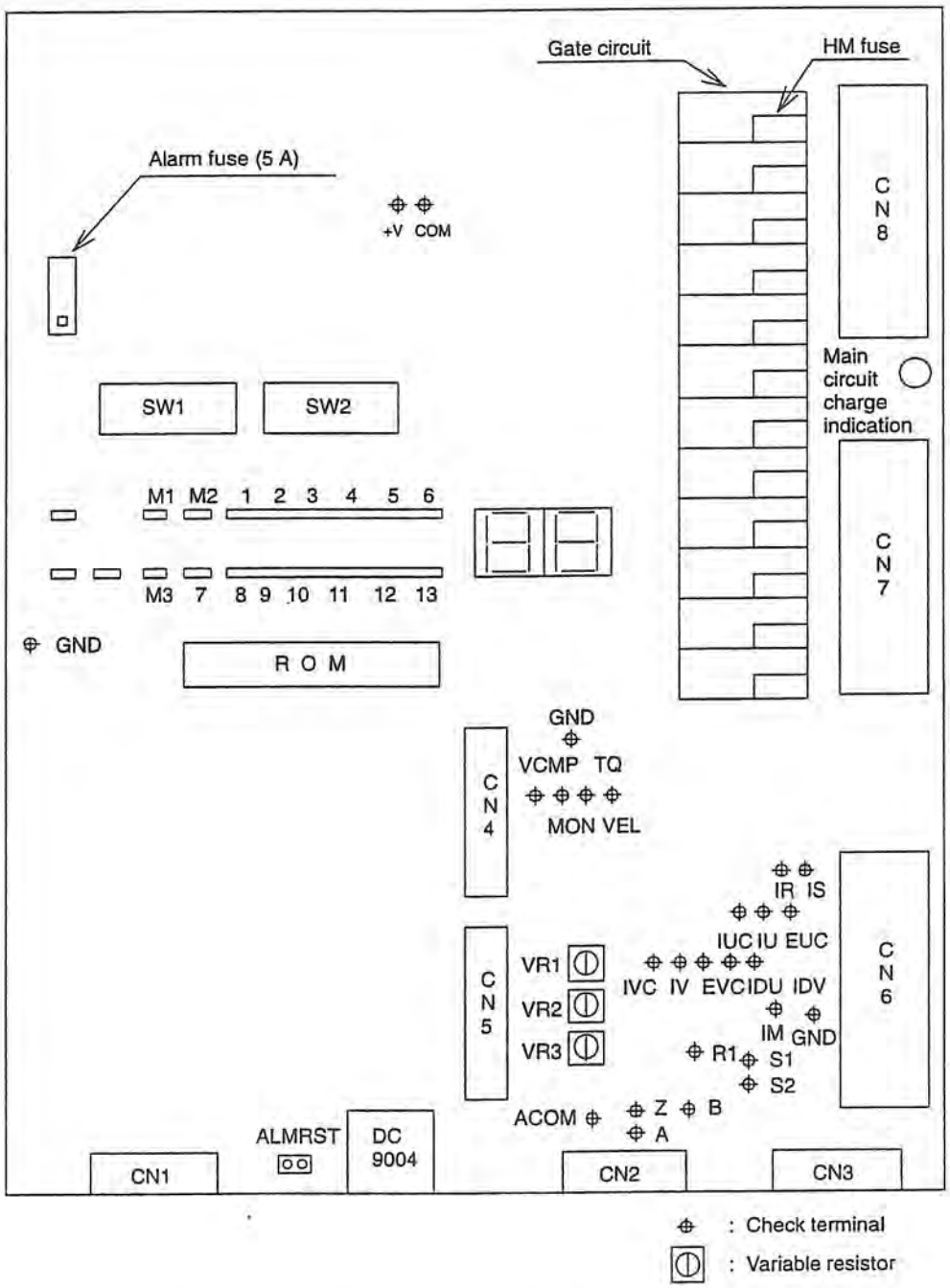


Fig. 1-5 Arrangement of Major Component Parts on VAC-Board-III for VACIII-D11, -D22 Unit

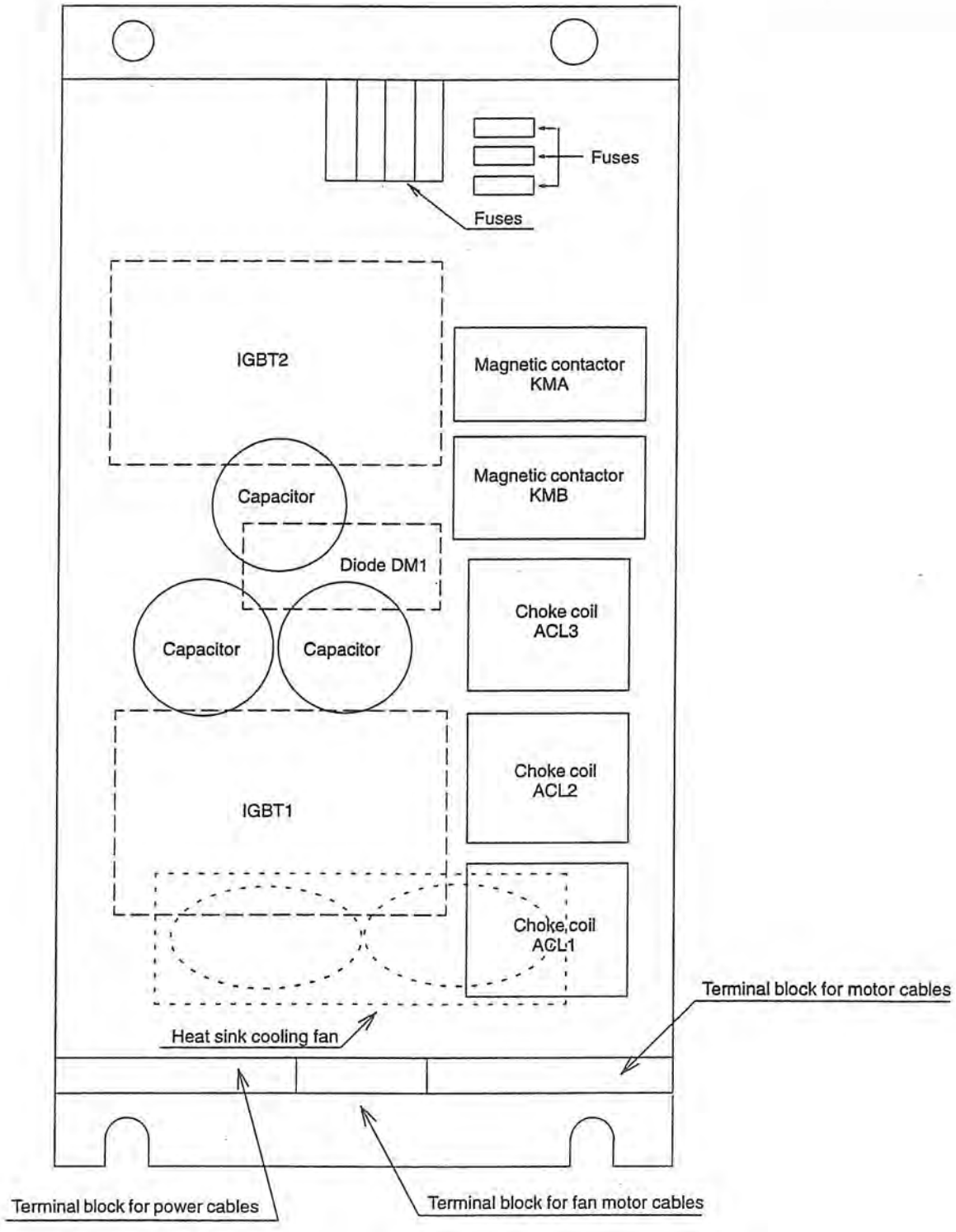


Fig. 1-6 Arrangement of Major Component Parts on Power Unit for D6

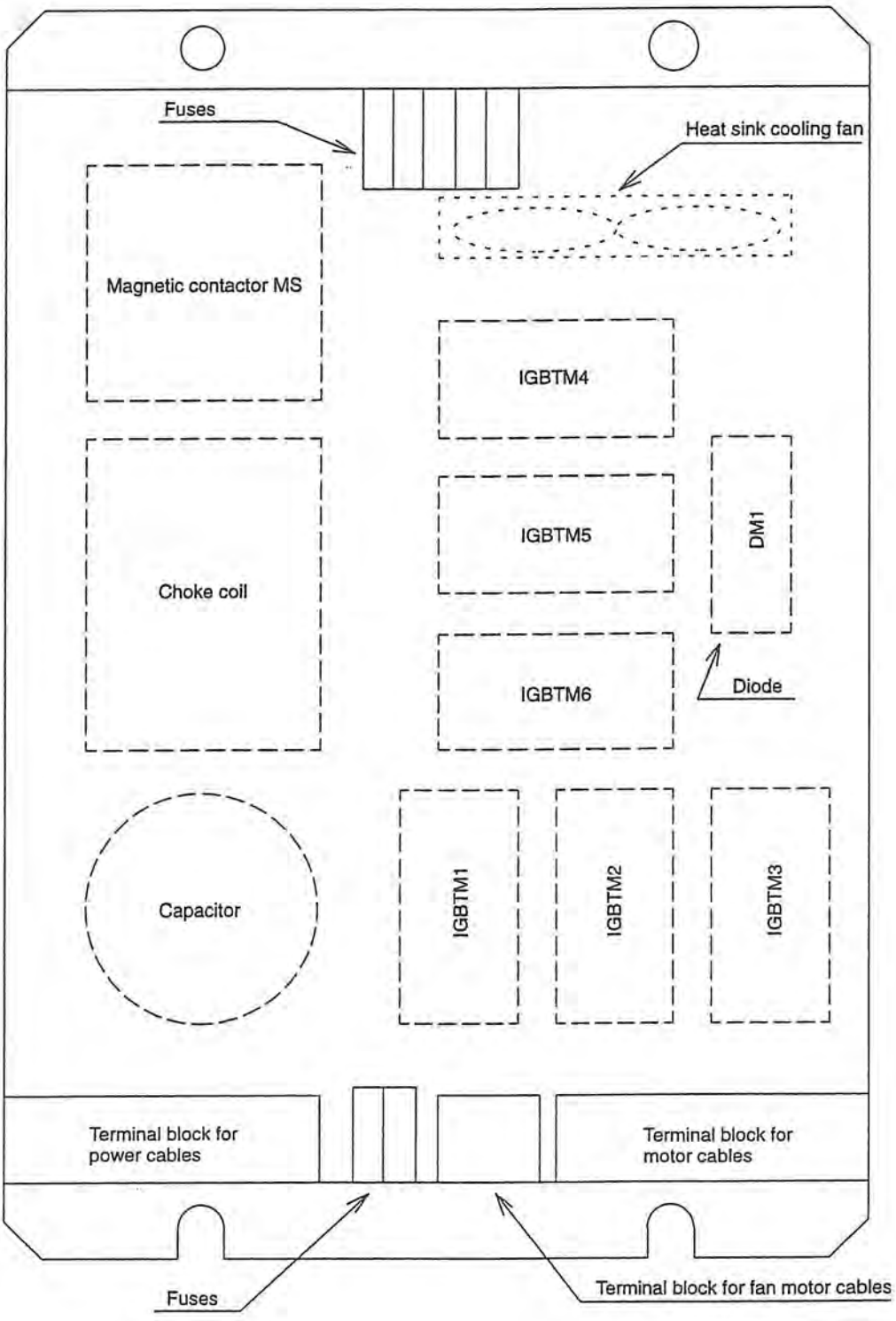


Fig. 1-7 Arrangement of Major Component Parts on Power Unit for D11

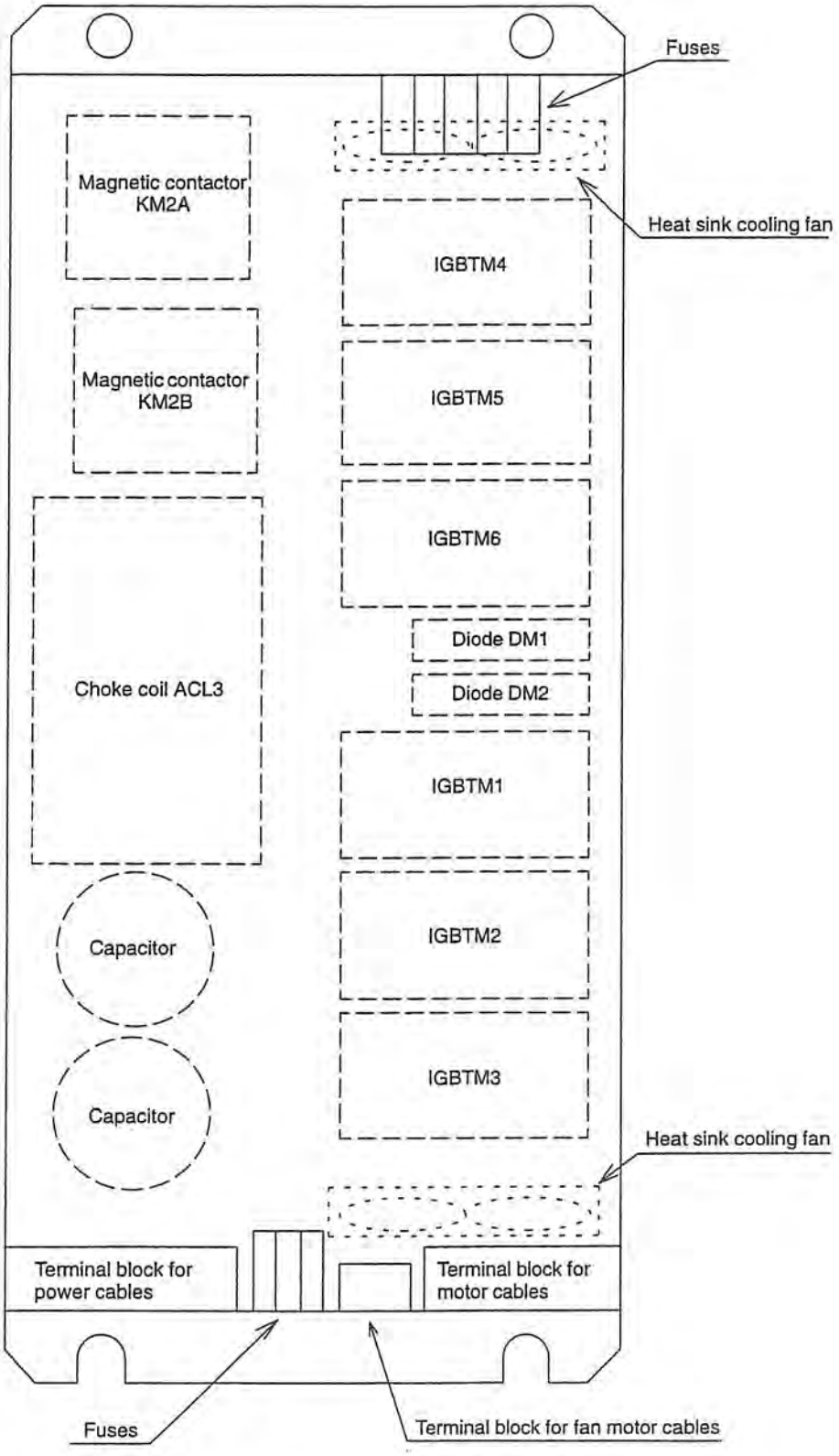


Fig. 1-8 Arrangement of Major Component Parts on Power Unit for D22

1-2. VAC Motor

VAC motor configuration is shown in the illustration below.

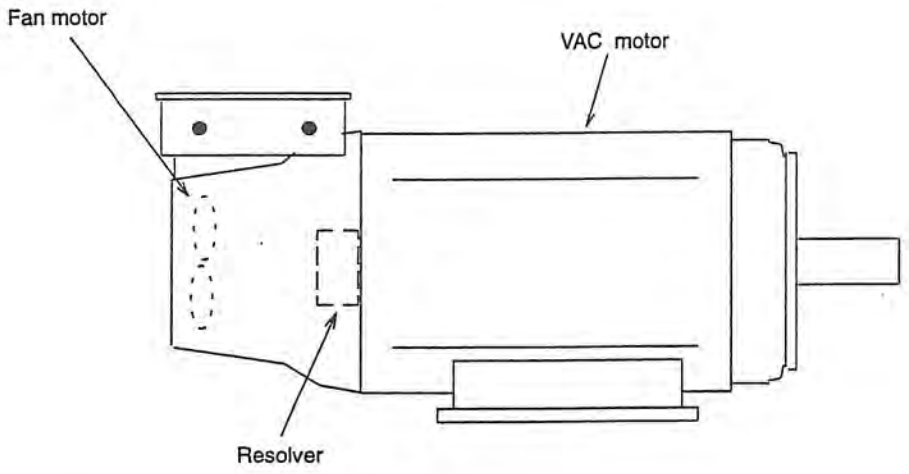


Fig. 1-9 VAC Motor Configuration

2. COMBINATION OF VACIII DRIVE UNIT AND VAC MOTOR

Motor \ Unit			Unit Size		
30-minute Continuous Rating (kW (HP))		Continuous Rating Output Current (A rms)	D6	D11	D22
STANDARD SERIES	3.7/2.2 (5/3)	20	○		
	5.5/3.7 (7.5/5)	28	○		
	7.5/5.5 (10/7.5)	37	○		
	11/7.5 (15/10)	46		○	
	15/11 (20/15)	74		○	
	18.5/15 (25/20)	97			○
	22/18.5 (30/25)	120			○
	30/22 (40/30)	122			○
WINDING CHANGEOVER SPECIFICATION	5.5/3.7 (7.5/5)	25	○		
	7.5/5.5 (10/7.5)	37	○		
	11/7.5 (15/10)	50		○	
	15/11 (20/15)	65		○	
	18.5/15 (25/20)	83			○
	22/18.5 (30/25)	95			○

SECTION 2 MAINTENANCE AND INSPECTION

1. INSPECTION DURING INSTALLATION

1-1. Environmental Requirements

(9) Ambient Temperature

- During operation

  Ambient temperature of unit : 0°C to 55°C

  Ambient temperature of control cabinet: 0°C to 45°C

- During transportation and storage

  Ambient temperature of unit : –20°C to 60°C

(10) Humidity

Under normal operation status : 75%RH max.

For short period (within 1 month) : 95%RH max.

There must be no condensation.

(11) Vibration

During operation: 0.5G max.

(12) Ambient Atmosphere

Must not be exposed to coolant, lubricating oil, chips, etc.

1-2. Inspection of Source Voltage

(1) Source Voltage Specification and Allowable Voltage Range

a) Specification

The VACIII drive unit operates at 200V AC (3 phases).

b) Allowable range

180V to 220V AC (49 to 62 Hz)

(2) Capacity of Power Source

Motor Size (kW (HP))	Unit Size	Power Capacity (kVA)
3.7/2.2 (5/3)	D6	6
5.5/3.7 (7.5/5)		8
7.5/5.5 (10/7.5)		11
11/7.5 (15/10)	D11	16
15/11 (20/15)		22
18.5/15 (25/20)	D22	28
22/18.5 (30/25)		33
30/22 (40/30)		45

(3) Impedance of Power Source

Check source voltage variation according to the procedure explained in Section 7, 4. "CALCULATING SOURCE VOLTAGE MOMENTARY FLUCTUATION RATIO".

2. DAILY INSPECTION

(1) Inspection of VAC Motor

If foreign matter and dust accumulate on the ventilation hole and fan guard of the VAC motor, heat radiation efficiency of the motor is lowered. Clean them with compressed air or a vacuum cleaner.

(2) Inspection of VACIII Drive Unit

At the back of VACIII drive unit, heat sink cooling fan is mounted. Therefore, foreign matter and dust will accumulate on the heat sink during operation for a long time. If accumulation of foreign matter and dust becomes noticeable, clean them with a vacuum cleaner.

3. INSTRUMENTS AND PARTS USED FOR MAINTENANCE

Instruments used for maintenance are indicated in Table 2-1.

Table 2-1 Maintenance Instruments

Name	Specifications	Use
AC voltmeter	300 V	For measuring power supply voltage
Analog circuit tester	Market product	For checking resistance
Phillips screwdriver	Large, medium, small	

Components parts used in the VACIII drive unit and those necessary for maintenance are indicated in Table 2-2.

Table 2-2 Maintenance Parts for VACIII Drive Unit

	Name	Type	Okuma Part No.	Q'ty		
				D6	D11	D22
POWER UNIT	IGBT module	6MBI100FA-060 100 A 600 V (Fuji)	E4443-722-043	2		
		CM150DY-12E 150 A 600 V (Mitsubishi) 2MBI150LB-060 150 A 600 V (Fuji)	E4443-820-021		3	
		CM200DY-12E 200 A 600 V (Mitsubishi) 2MBI200LB-060 200 A 600 V (Fuji)	E4443-820-022		3	
		CM300DY-12E 300 A 600 V (Mitsubishi) 2MBI300LB-060 300 A 600 V (Fuji)	E4443-820-029			3
		CM400DY1-12E 400 A 600 V (Mitsubishi)	E4443-820-030			3
	Diode module	RM200HA-12F 200 A 600 V (Mitsubishi)		1		
		RM100C2Z-H 100 A 800 V (Mitsubishi)	E2714-820-005		1	
	Fuse	F·G·B·O 5 A 250 V (Fujiterminal)	E2442-727-003	4	4	5
		F·G·B·O 0.5 A 250 V (Fujiterminal)	E2445-727-004		3	3
		HM05 0.5 A (Daito Tsushin)	E2445-392-226	3		
CONTROL BOARD	Alarm fuse	MP50 5 A (Daito Tsushin)	E2445-392-215	1	1	1
	Gate circuit fuse	HM03 0.3 A (Daito Tsushin)	E2445-392-213	12	12	12

4. OPERATION STATUS INDICATION

Indication by the LED's is visible through the opening in the cover.

Fig. 2-1 shows the LED names.

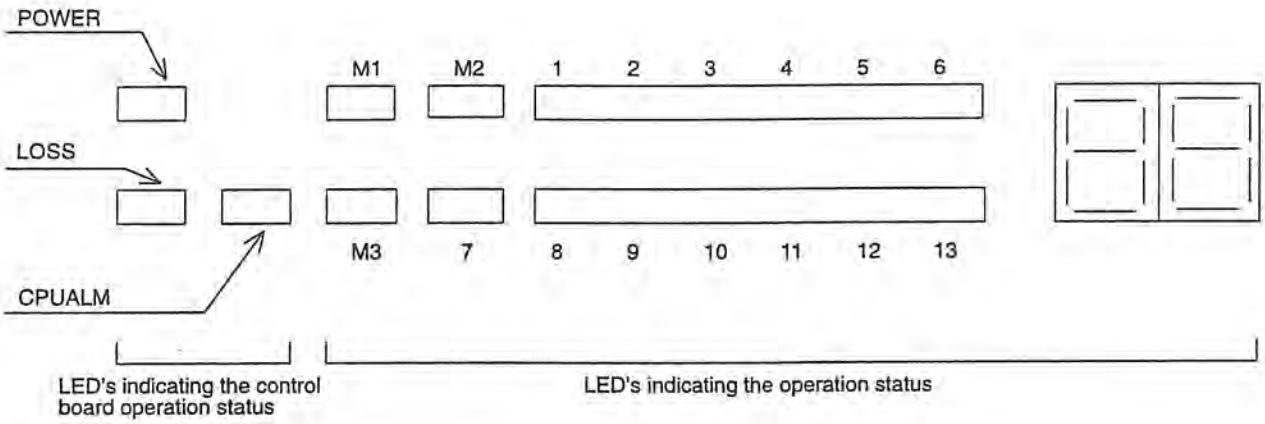


Fig. 2-1 LED Names

4-1. LED's Indicating Control Board Operating Status

The following three LED's indicate the operation status of the VACIII drive unit. The relationship between the lit LEDs and the control board operating status is indicated in Table 2-3.

Table 2-3 Relationship between LED Illumination and Control Board Operation Status

Name	Color	Operation	Remarks
POWER	Green	Power supply for VACIII drive unit control circuit is being supplied.	If this is not illuminating while power supply to the VACIII drive unit is on, it indicates an occurrence of a trouble.
LOSS	Red	Voltage in the calculation circuit of the VACIII drive unit is outside the specification.	If this LED is turned on, the calculation circuit is not functioning normally.
CPUALM	Red	The lamp indicates an occurrence of a problem in the calculation circuit in the VACIII drive unit.	Contents of the problem are indicated by the operation status LED's.

4-2. LED's Indicating the Operating Status

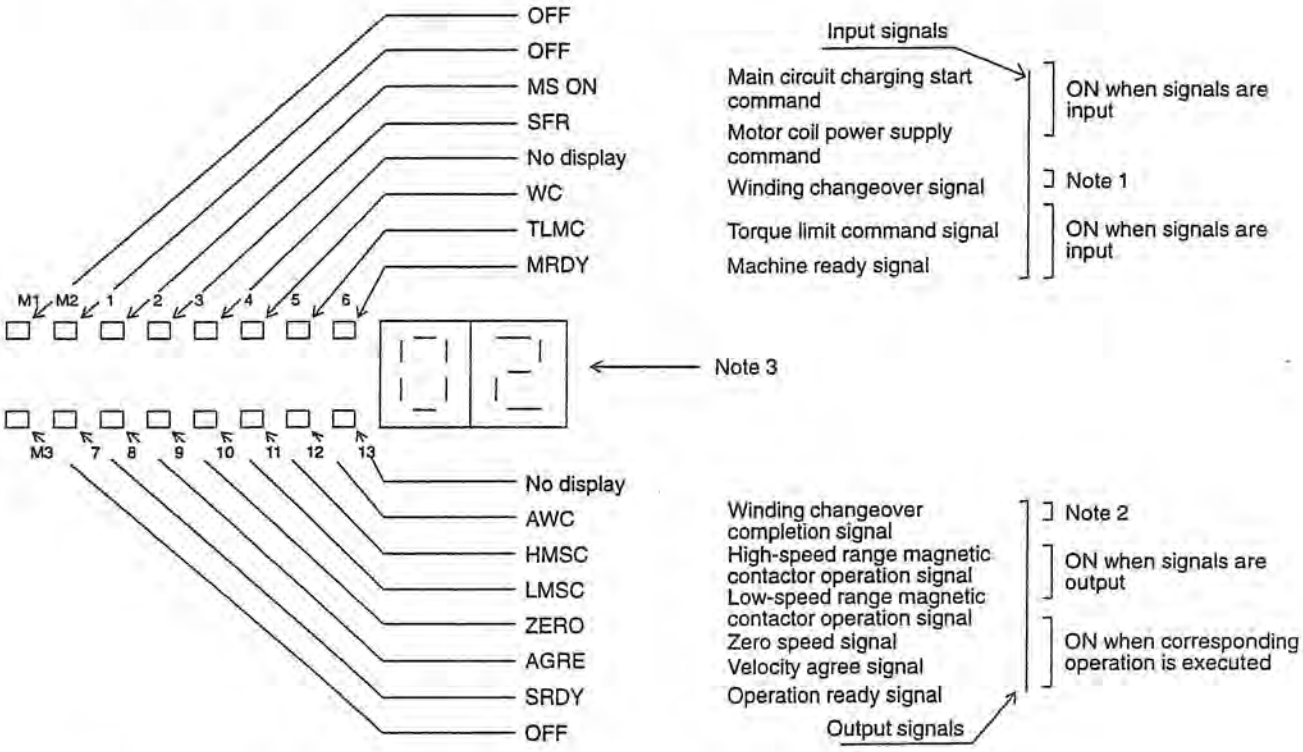
The LED's M1, M2 and M3 indicate the operation status of the VAC drive unit and the VAC motor.

There are two different operations status as "normal operation" and "faulty operation". They are indicated by the following LED illumination conditions.

Normal operation : M1, M2 and M3 are all OFF.

Faulty operation : M1, M2 and/or M3 is ON or flickering.

For details of "faulty operation status", refer to 4-3. "Failure Operation Status Indication".



Note 1: WC (Winding changeover signal)

ON : when the high-speed range winding selection command is input

OFF : when the low-speed range winding selection command is input

Note 2: AWC (Winding changeover completion signal)

ON : when the high-speed range winding selection is completed

OFF : when the low-speed range winding selection is completed

Note 3: When the power to the machine is turned on, it indicates "01". When the control power is turned on and the NC is ready, the indication changes to "02".

Fig. 2-2 Signal Assignment at LED's for Normal Operation

4-3. Failure Operation Status Indication

A faulty operation status is indicated by the LED's M1 and M2 in the following conditions.

- M1 and M2 flicker simultaneously.
- M1 lights up.
- M2 lights up.

LED's other than M1 and M2 light up corresponding to the failure conditions occurred to indicate them.

On the VAC III control PCB, the 7-segment LED displays the failure operation status by the 2-digit number.

The alarm information is transferred to the NC unit, and alarm name and alarm data are displayed on the CRT screen of the NC operating panel.

Concerning the VACIII drive unit failure operation status, detailed explanation is given below.

(1) Alarm Type

There are two types of alarm with the spindle servo unit. One is detected in the VAC III drive unit, and the other is detected in the NC.

Spindle Servo Unit Alarms
- a) Alarms detected in the VAC III drive unit
  - Power circuit alarms (IOCM, IOCS, OV UV, etc.)
  - Calculation circuit alarms (AD, PAR, LOOP, etc.)
  - Others
- b) Alarms detected in the NC unit
  - VAC data file read alarm
  - VAC start alarm
  - VAC communication alarm
  - Others

(2) Alarm Indication

The VACIII alarm is indicated in the following three places.

a) The NC operating panel

Alarm name and alarm data are displayed.

b) 7-segment LED on the VACIII control board

Alarm number is displayed.

c) Single LED on the VACIII control board

The LED corresponding to the alarm contents lights up.

Alarms to be detected in the VACIII drive unit and those detected in the NC unit are displayed at the location indicated in Table 2-4.

The VACIII drive unit has LED's on the control board to indicate the operation status.

Table 2-4

	(1) NC operatiing panel	(2) 7-segment LED on the VACIII control board	(3) Separate LED on the VACIII control board
(1) Alarms detected in the VACIII drive unit	○	○	○
(2) Alarms detected in the NC unit	○	×	×

Note 1: "○" indicates "displayed", and "×" indicates "not displayed".

Note 2: When more than one alarm occurred, the alarm of the highest level is displayed. When the alarms of the same level occurred, the alarm detected first will be displayed.

Note the separate LEDs on the VACIII control board corresponding to the alarms occurred will all light up.

Note 3: For the alarm which occurred after the main power to the NC is turned on but before the NC gets ready, "VAC start" is displayed on the CRT in the NC operating panel.

In this case, open the NC control cabinet with the main power ON, and check the alarm contents from the 7-segment LED and the separate LED on the VACIII control board.

(3) Alarm Contents

a) Alarm indication on the NC operating panel

Refer to the alarm list of each NC system.

b) Alarm indication by the 7-segment LED on the VACIII control board

Refer to Table 2-5, "VACIII Drive Unit Alarm List".

c) Alarm indication of the separate LED's on the VACIII control board

Refer to Table 2-7, "Failure Operation Status Indication Mode".

Failure contents are detailed in Figs. 2-3 through 2-5.

Table 2-5 VACIII Drive Unit Alarm List (1/3)

Alarm No.*	Alarm Name	Alarm Level	Processing Level	Contents
1	Pulse generator count	1b	2	The number of the detected PG counts exceeds the PBU data.
2	Excessive motor speed	1a	1	The actual VAC motor speed is too high.
3	APA speed	1b	2	The actual spindle speed is too high.
4	CON speed	1b	2	Excessive velocity command value in the spindle control mode or excessive feedrate unit amount in the C-axis control mode. Excessive feedrate unit amount per communication, or calculation of the position command is delayed from the timing of communication.
5	DIFF overflow	2	3	In the C-axis control mode, position deviation exceeded the specified value.
6	Resolver error	1a	1	The VAC resolver signal is not output.
7	RAM parity error	1a	1	Read/write from/to the RAM cannot be carried out correctly.
8	Communication error	1b	1	Communication data between the VAC and the NC is stopped, or communication data is faulty.
9	Instruction (command)	1b	2	The command communicated is undefined or not executable.
10	Motor cable overcurrent	1a	1	Instantaneous overcurrect in the VAC motor cable
11	Inverter bridge short circuit	1a	1	Short circuit in the inverter bridge arm
12	Regeneration transistor short	1a	1	Overcurrent in the regenerative main circuit
13	Power circuit overvoltage	1a	1	Excessive DC voltage in the main circuit
14	Input voltage drop	1a	1	The three-phase input power supply voltage is lower than the specified value.
15	Phase defect	1a	1	Any of the three-phase input is open.
16	Arithmetic unit volt drop	1a	1	Control power supply voltage on control board is low.
17	Power circuit low voltage	1a	1	DC voltage in the main circuit does not rise.
18	Interval loop error	1a	1	Interruption cannot be performed correctly.

* 7-segment LED

Note 1: For the alarm level, refer to Section 3, 4. "RECOVERY FROM FAILURE STATUS".

Note 2: The processing level show the priority of releasing alarms. For VAC operation corresponding to the processing level, see Table 2-6.

Table 2-5 VACIII Drive Unit Alarm List (2/3)

Alarm No.*	Alarm Name	Alarm Level	Processing Level	Contents
19	Motor overload	3	4	The temperature inside the VAC motor is higher than the permissible value. *Note: If this alarm occurs, the status transfers to processing level 3 30 seconds after the occurrence of this alarm.*
20	Heat sink overload	3	4	The temperature of the heat sink in the drive unit is higher than the permissible value. *Note: If this alarm occurs, the status transfers to processing level 3 30 seconds after the occurrence of this alarm.*
21	VAC data setting	1b	2	The set VAC PBU data or the on-line change parameter setting is abnormal. (The data outside the data setting range is set of sent.)
22	Internal speed command over	2	3	Excessive velocity command value during velocity control or position control in the VAC.
23	Magnetic pulse generator	1a	1	The magnetic encoder signal is not output.
24	Pulse generator marker data	1b	2	The number of counts until the first marker is passed after the power has been turned on exceeds the PBU data.
25	Cycle overflow error	1a	1	A cycle over error occurred.
26	Watchdog error	1a	1	The watch dog timer is not cleared.
27	Analog-to-digital access alarm	1a	1	A/D access is attempted during A/D conversion.
28	Master cpu error	1a	1	The master CPU on the VACIII control board can detect: Bus error, prohibiting instruction error, division by zero error, CHK instruction error, TRAPV instruction error, privilege violation error, trace error, 1010 emulator error, 1111 emulator error, unused area error, address error, interruption error, TRAP error, user interruption error, spurious interruption error.
29	Slave cpu error	1a	1	The slave CPU on the VACIII control board can detect: Bus error, prohibiting instruction error, division by zero error, CHK instruction error, TRAPV instruction error, privilege violation error, trace error, 1010 emulator error, 1111 emulator error, unused area error, address error, interruption error, TRAP error, user interruption error, spurious interruption error.

* 7-segment LED

Table 2-5 VACIII Drive Unit Alarm List (3/3)

Alarm No.*	Alarm Name	Alarm Level	Processing Level	Contents
30	Speed deviation too large	1a	1	Excessive VAC motor velocity deviation
31	Coil switch	1a	1	The winding changeover MS is not turned on.
32	RAM error	1a	1	The contents of the RAM cannot be cleared when the power is turned on.
33	High speed motor parameter setting	1a	1	The motor parameter data in the PBU data file is abnormal.
34	Power supply voltage flutter over	3	4	Power source impedance is greater than the allowable limit.
35	Master CPU down	1a	1	The CPU on the VACIII control board has stopped.

* 7-segment LED

Table 2-6 Alarm Processing Level

Alarm Processing Level	VACIII Drive Unit Operation
1	Shut off current to set the motor coast.
2	Shut off current after reducing speed and stopping the motor.
3	Shut off current after reducing speed and stopping the motor. See Note.
4	Alarm indication is given by the 7-segment LED. Operation is continued although the alarm state information is output to the NC unit.

Note: The VACIII drive unit performs the same operation in alarm processing levels 2 and 3 though there is difference in internal processing.

Table 2-7 Failure Operation Status Indication Mode

LED Status				Failure Contents		7-segment LED
M1	M2	M3	Lighting LED No.			
Flashing	Flashing	Un-known (ON/ OFF)	1	RES	Resolver error	06
			2	AD	A/D access alarm	27
			3	PAR	RAM parity error	07
			4	ACC	Cycle over error	25
			5	LOOP	INT loop error	18
			6	WDOG	Watchdog error	26
		ON	7	IOCM	Motor cable overcurrent	10
			8	IOCS	Inverter bridge short	11
			9	IOCR	Regeneration IGBT short	12
			10	OV	Power circuit overvoltage	13
			11	UV	Input voltage drop	14
			12	PH	Open phase	15
			13	LOSS	Loss of calculation circuit power	16
ON	OFF	OFF	1	OS	Excessive motor speed	02
			2			
			3	UVP	Power circuit low voltage	17
			4	RAER	RAM error	32
			5			
			6	DSC	Excessive velocity deviation error	30
			7	LO4	INT loop error	18
			8	LO1	INT loop error	18
			9	WCE	Winding changeover error	31
OFF	ON		1	OH	Heat sink overheat	20
			2	OL	Motor overload	19

Note: M3 lights when an alarm occurs with the power circuit (IOCM, IOCS, IOCR, OV, UV, PH, LOSS).

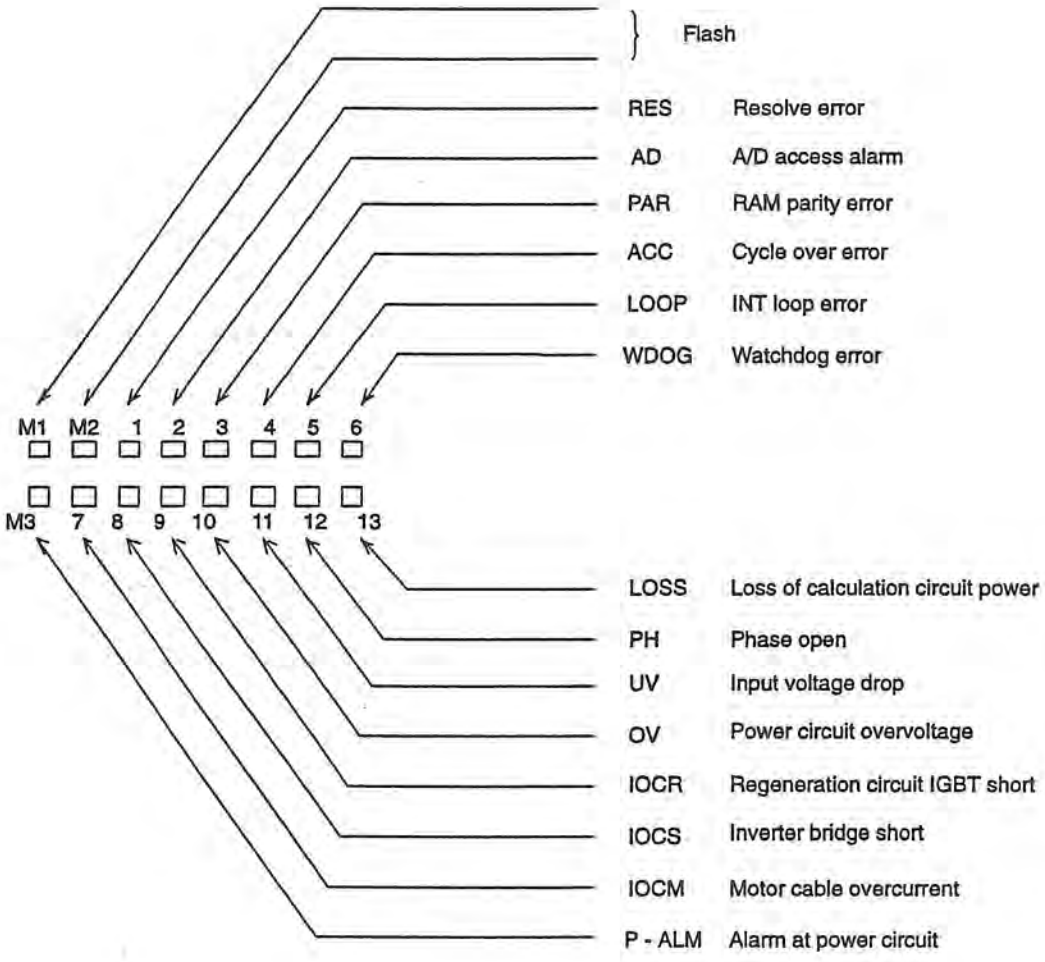


Fig. 2-3 Failure Indication by LED's (With M1 and M2 LED's Flashing)

SECTION 3 TROUBLESHOOTING

1. CAUTIONS ON TROUBLESHOOTING

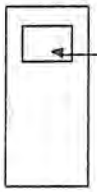
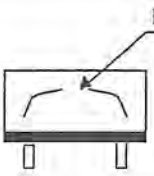
Before inspecting or repairing the power unit, record the indication given by the LED's. After that turn off the power. With the VACIII-D6 unit, you are allowed to inspect or repair the VACIII drive unit after an elapse of 1 minute. With the VACIII-D11 or -D22 unit, you are allowed to inspect or repair the VACIII drive unit after making sure that the main circuit charged indicating LED on the control board has been turned off.

⚠WARNING : Just after turning off the power to the VACIII drive unit, high voltage remains applied to the components inside the unit and careless touching of these components will cause electric shock. Allow the components to discharge before starting repair.

2. FUSE CHANGE

Blown conditions of fuses used in the VACIII drive unit are shown in Table 3-1.

Table 3-1 Fuse Blown Conditions

Fuse Name	Blown Condition
Fuses	 The fuse element is blown as illustrated to the left when viewed from the front.
Alarm fuses MP50	 The white fuse blown indication appears at upper portion of the fuse cartridge when viewed from the front.
Gate circuit fuses HM03 HM05	 The fuse element is blown as illustrated at the left when viewed from the front. There might be cases where the disconnection cannot be found visually.

2-1. Inspection and Changing Procedure for Fuses

(1) Take the fuse out of the fuse holder.

(2) Measure resistance across the glass-tube filled fuse element using a multimeter.
Reading must be 0 Ω. When it is "∞" it indicates that the fuse has been blown.

(3) If the fuse is blown, change the fuse.

(4) Set the fuse in the fuse holder. If the fuse is provided with a cover, do not forget to set the cover.

2-2. Fuse Rating

The rating of the fuses to be used on the VACIII control board and the power unit are indicated in Table 3-2.

Table 3-2 Fuse Current Rating

Unit Size	Fuse Rating (A)									
	F1R	F1S	F2R	F2S	F2T	F3R	F3S	F3T	MP50	HM03
D6	5	5	5	5	–	0.5	0.5	0.5	5	0.3
D11	5	5	5	5	–	0.5	0.5	0.5	5	0.3
D22	5	5	5	5	5	0.5	0.5	0.5	5	0.3

For details of the fuses, refer to Section 2, 3. "INSTRUMENTS AND PARTS USED FOR MAINTENANCE".

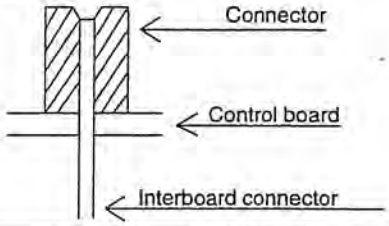
3. TROUBLESHOOTING PROCEDURE

For the arrangement of the parts, refer to Section 1, 1-1. "VACIII Drive Unit".

3-1. Confirmation of Power Supply and Connectors

Before carrying out the steps explained in 3-2. "Classification of Failures and Corresponding Measures".

Table 3-3 Confirmation of Power Supply and Connectors

Items to Check	How to Check	Measures to Take
DIP switches SW1 to SW2	All OFF	Set as indicated.
Variable resistor	All "0"	Set as indicated.
Power supply	Measure voltage across input terminals R, S, T of VACIII drive unit and power supply grounding terminal to check if it is within the allowable range. Allowable range: 180 to 220V AC (49 to 62 Hz)	Correct input power supply so that it is within the allowable range.
Connectors	Make sure that the MR connectors are all secured by screws. The interboard connector must be securely inserted.	Connect correctly. 

⚠WARNING : High voltage is applied. Pay attention to electric shock when checking the power supply.

3-2. Classification of Failures and Corresponding Measures

If a problem occurred, take the proper measures referring to Table 3-4.

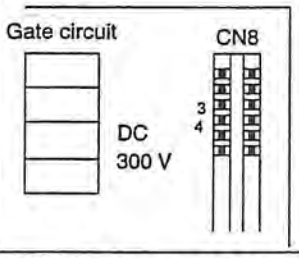
For the method of inspection or replacing each parts, refer to Section 6. "CHANGING THE CONTROL BOARD AND UNITS".

Table 3-4 Classification of Failures

Failure	Reference	Failure will Lie in	
		Control Board	Power Unit
POWER LED does not light up.	(1)	○	○
LOSS LED lights up.	(1)	○	○
LED's show failure occurrence condition.	(2)	○	○
Motor hunts.	(3)	○	○
Commanded motor speed cannot be obtained.	(4)	○	○
Motor does not rotate.	(4)	○	○
Low cutting performance	(5)	○	○
Long acceleration and deceleration time	(6)	○	○
Excessive vibration and noise while the motor is rotating.	(7)	○	○

3-2-1. POWER LED Does Not Light Up
LOSS LED Light Up

Table 3-5

Failure Factor	Check	Measures
Input power supply is abnormal.	Refer to Table 3-3.	Refer to Table 3-3.
Fuse (F∗∗) or alarm fuse (MP50) is blown.	Check whether the fuses have been blown or not. (Refer to 2-1 "Inspection and Changing Procedure for Fuses".)	Change blown fuse.
PCB connector is not inserted properly.	Check to be sure that the interboard connector can be seen t the surface of the connector on the control board.	Insert the connector properly.
Power is not supplied to the control board from the power unit.	- Detach the cover. - Check voltage across pins 3 and 4 of connector CN8 (pins 1 and 32 of connector CN5 in the case of VA-CIII-D6 unit) 	Change the power unit. (Refer to Section 6, 1. "CHANGING THE POWER UNIT".
Control board is faulty.	Make sure that all the items above are correct	Change the control board. (Refer to Section 6, 2. "CONTROL BOARD CHANGING PROCEDURE".)

: High voltage is applied to the base circuit and regeneration circuit. Special care must be exercised when checking the power supply of the control board.

3-2-2. LED's Show Failure Occurrence Connection

When LED's show failure occurrence condition, take necessary measures in accordance with the alarm number displayed on the VACIII control board. For the alarm name and the alarm contents, refer to Table 3-6, "VACIII Alarm List".

Table 3-6

Alarm No.	Alarm Name	Failure Factor	Check	Measures
1	Pulse generator count	The magnetic encoder sensor or the gear is faulty.	Rotate the spindle by hand and check the output signals of the encoder. (Refer to Section 7, 5. "MAGNETIC ENCODER OUTPUT SIGNAL" when checking the output signals of the encoder.)	Change the sensor or the gear.
		The control board is faulty.	Make sure that all the items above are correct.	Change control board.
2	Excessive motor speed	The resolver is faulty.	Rotate the resolver by hand and check the output signals. (Refer to Section 7, 1. "CHECK TERMINALS" when checking the output signals.)	Change the motor.
		The magnetic encoder sensor or the gear is faulty.	Rotate the spindle by hand and check the output signals of the encoder. (Refer to Section 7, 5. "MAGNETIC ENCODER OUTPUT SIGNAL" when checking the output signals.)	Change the sensor or the gear.
		Loose connection of the connectors of motor signal cables or magnetic encoder signal cables	Check whether connector and the connector in the motor terminal box are inserted properly.	Insert them properly.
		Disconnection of motor signal cables or magnetic encoder signal cables	Remove the motor signal cables or the magnetic encoder signal cables and conduct the continuity test.	Change the motor signal cables or the magnetic encoder signal cables.
		The control board is faulty.	Make sure that all the items above are correct.	Change the control board.

Alarm No.	Alarm Name	Failure Factor	Check	Measures
3	APA speed	The magnetic encoder sensor or the gear is faulty.	Rotate the spindle by hand and check the output signals of the encoder. (Refer to Section 7, 5. "MAGNETIC ENCODER OUTPUT SIGNAL" when checking the output signals.)	Change the sensor or the gear.
		Loose connection of the connector of magnetic encoder signal cables	Check whether connector is inserted properly.	Insert them properly.
		Disconnection of magnetic encoder signal cables	Remove the magnetic encoder signal cables and conduct the continuity test.	Change the magnetic encoder signal cables.
		The control board is faulty.	Make sure that all the items above are correct.	Change the control board.
4	CON speed	Faulty NC software (setting error for feed unit amount)	Check the setting value.	Change the setting value.
5	DIFF overflow	Operation in overloaded condition	Check the cutting conditions. Check the machine for mechanical troubles: lubricating oil, etc.	Change the cutting conditions. Remove the mechanical trouble factor.
		The control board is faulty.	Make sure that all the items above are correct.	Change the control board.
6	Resolver error	Loose connection of the connectors of motor signal cables	Check whether or not connector and the connector in the motor terminal box are inserted properly.	Insert them properly.
		Disconnection of motor signal cables	Remove the motor signal cables and conduct the continuity test.	Change the motor signal cables.
		The control board is faulty.	Make sure that all the items above are correct.	Change the control board.
		The resolver is faulty.	Make sure that the RES is indicated even after the change of the control board.	Change the motor.
7	RAM parity error	The control board is faulty.	—	Change the control board.

Alarm No.	Alarm Name	Failure Factor	Check	Measures
87	Communication error	Loose connection of the connectors of optical fiber cables	Check whether or not connectors of optical fiber cables of control board are inserted properly.	Insert them properly.
		Disconnection of optical fiber cables	Check whether or not optical fiber cables are broken. (Refer to Section 7, 2. "INSPECTION OF OPTICAL FIBER CABLE" when checking the optical fiber cables.)	Change the optical fiber cables.
		TFP board on the NC unit is faulty.	Make sure that all the items above are correct.	Change TFP board.
		The control board is faulty.	Make sure that all the items above are correct.	Change the control board.
9	Instruction (command)	Faulty NC software (Undefined instruction or non-executable instruction is communicated.)	Check the communication in which an alarm occurs.	Correct the NC software.
10	Motor cable overcurrent	Loose connection of motor power cables at terminal block	Check terminal screws for looseness.	Tighten the terminal screws securely.
		Motor power cables are disconnected, interphase short-circuited, or grounded.	Disconnect the motor power cables from the VACIII drive unit and the VAC motor, and check continuity.	Change the cables.
		The VAC motor is faulty.	Measure resistance between the motor power cable terminal and the frame using a megger insulation tester.	Change the motor.
		The control board is faulty.	Make sure that all the items above are correct. (Check the settings at DIP switches SW3 and SW4.)	Change the control board.
		The power unit is faulty.	Make sure that the No. 10 is indicated even after the change of the control board.	Change the power unit.
11	Inverter bridge short circuit	The control board or the power unit is faulty.	Check the fuse and IGBT on the control board.	Refer to 2 "FUSE CHANGE" and Section 6, 3-1. "Inspecting and Changing the IGBT".

Alarm No.	Alarm Name	Failure Factor	Check	Measures
11	Inverter bridge short circuit	Interphase short-circuit in the motor power cable.	Disconnect the motor power cables from the VACIII drive unit and the motor, and check continuity.	Change the cables.
		The VAC motor is faulty.	Measure resistance between the motor power cable terminal and the frame using megger insulation tester.	Change the motor.
		Magnetic contactor for winding changeover or magnetic contactor drive relay is faulty.	Refer to the maintenance manual for the machine.	Change the magnetic contactor or magnetic contactor drive relay.
12	Regeneration transistor short	An instantaneous power failure occurs while the motor is stopped.	Check the power supply.	Reset and restart.
		The control board or the power unit is faulty.	Check the fuse and IGBT on the control board.	Refer to 2 "FUSE CHANGE" and Section 6, 3-1. "Inspecting and Changing the IGBT".
13	Power circuit overvoltage	Source voltage is abnormally high.	Refer to Table 3-3.	Refer Table 3-3.
		Power supply cable terminal screws are loose.	(1) Turn power supply off. (2) Check the screws if they are loose.	Secure the screws tightly.
		The regeneration circuit is faulty.	Change the whole unit.	Refer to Section 6, 1 "CHANGING THE POWER UNIT" and 2. "CONTROL BOARD CHANGING PROCEDURE".
		Power source impedance is high.	The No. 13 lamp lights up only while decelerating.	Use a power supply with a low impedance.
14 or 15	Input voltage drop Phase defect	Power supply voltage is low, or one of three phases is open.	Refer to Table 3-3.	Refer to Table 3-3.
		Fuse F1R to F3T is blown.	Check whether the fuses have been blown or not.	Change blown fuse.

Alarm No.	Alarm Name	Failure Factor	Check	Measures
14 or 15	Input voltage drop Phase defect	(D6 unit) IGBT2 screw is loose. (D11, D22 unit) IGBTM4 to 6 screws are loose.	(D6 unit) Check IGBT2 screw. (D11, D22 unit) Check IGBTM4 to 6 screws.	Secure the screw tightly.
		(D6 unit) IGBT2 is faulty. (D11, D22 unit) IGBTM4 to 6 are faulty.	(D6 unit) Check IGBT2. (D11, D22 unit) Check IGBTM4 to 6.	Change the IGBT module. Refer to Section 6, 3-3. "Changing the Semiconductor Devices in the Main Circuit".
		The interboard connector is not plugged in properly.	—	Insert the connector properly.
		The control board is faulty.	Make sure that all the items above are correct.	Change the control board.
		The power unit is faulty.	Check to be sure that the alarm No. 14 or No. 15 is displayed even after the Change of the control board.	Change the power unit.
		Power source impedance is high.	The alarm No. 14 or No. 15 is displayed only during acceleration and deceleration of the motor.	Change the power supply with the one having a lower impedance.
16	Arithmetic unit volt drop	Refer to Table 3-5.	Refer to Table 3-5.	Refer to Table 3-5.
17	Power circuit low voltage	Source voltage is low.	Refer to Table 3-3.	Refer to Table 3-3.
		(D6 unit) IGBT2 screw is loose. (D11, D22 unit) IGBTM4 to 6 screws are loose.	(D6 unit) Check IGBT2 screw. (D11, D22 unit) Check IGBTM4 to 6 screws.	Secure the screw tightly.
		(D6 unit) IGBT2 is faulty. (D11, D22 unit) IGBTM4 to 6 are faulty.	(D6 unit) Check IGBT2. (D11, D22 unit) Check IGBTM4 to 6.	Change the IGBT module. Refer to Section 6, 3-3. "Changing the Semiconductor Devices in the Main Circuit".
		The interboard connector is not plugged in properly.	—	Insert the connector properly.
		The power unit is faulty.	Make sure that all the items above are correct.	Change the power unit.
		The control board is faulty.	The No. 17 lamp lights up after the change of the power unit.	Change the control board.

Alarm No.	Alarm Name	Failure Factor	Check	Measures
18	Interval loop error	The control board is faulty.	—	Change the control board.
19	Motor overload * An alarm is generated while the motor is rotating.	Operation in overloaded condition	Check the motor temperature.	Review the operation program.
		Disconnection of the fan motor cables at terminal block	The fan motor does not operate when power is turned on. - Check fan motor cable connection at the terminal block of the motor and the VACIII drive unit. - Check continuity	Connect the cables correctly.
		Fan motor cables are broken.		Change the fan motor cables.
		Fan motor is faulty.		Change the fan motor.
		Fan motor, fan guard, ventilation hole, etc. are contaminated.	Check contamination degree.	Clean with compressed air or using vacuum cleaner.
		Control board is faulty.	Make sure that all the items above are correct.	Change the control board.
	Motor overload * An alarm is generated frequently.	Loose connection of the motor signal cables	Check the connectors at the VACIII drive unit and in the motor terminal box. Are they inserted properly	Insert the connector properly.
		Disconnection of motor signal cables	Remove the signal cables and conduct the continuity test.	Change the signal cables.
		The thermostat relay the motor is faulty.	Measure the resistance between thermostat relay terminals of the connector in the VAC motor terminal box. If it is an infinite value (∞), it indicates that the thermostat relay is faulty.	Change the motor.
		Control board is faulty.	Make sure that all the items above are correct.	Change the control board.

Alarm No.	Alarm Name	Failure Factor	Check	Measures
20	Heat sink overload	PCB connector is not inserted properly.	—	Insert the connector properly.
		Heat sink cooling fan is faulty.	Check if the heat sink cooling fan is operating when power is turned on.	Change the power unit.
		Heat sink cooling fan and heat sink are contaminated.	Check contaminated condition at the back of the power unit.	Clean with compressed air or using vacuum cleaner.
		Operation in overloaded condition	—	Check the cutting conditions and cutting tools.
		Control board is faulty.	Make sure that all the items above are correct.	Change the control board.
		The power unit is faulty.	Make sure that the No. 20 is indicated after the change of the control board.	Change the power unit.
21	VAC data setting	Faulty NC software	Check the VAC PBU data or one-line change parameter.	Correct the faulty data.
22	Internal speed command over	Mechanical rouble around the spindle (collision, overload, etc.)	Check the machine for the mechanical trouble factor.	Remove the mechanical trouble factor.
23	Magnetic pulse generator	The magnetic encoder sensor is faulty.	Rotate the spindle by hand and check the output signal of the encoder. (Refer to Section 7, 5. "MAGNETIC ENCODER OUTPUT SIGNAL" when checking the output signals of the encoder.)	Change the sensor.
		Loose connection of the connectors of magnetic encoder signal cables	Check whether connector CN13 is inserted properly.	Insert the connector properly.
		Disconnection of magnetic encoder signal cables	Remove the magnetic encoder cables and conduct the continuity test.	Change the magnetic encoder signal cables.

Alarm No.	Alarm Name	Failure Factor	Check	Measures
24	Pulse generator marker data	The magnetic encoder sensor or the gear is faulty.	Rotate the spindle by hand and check the output signal of the encoder. (Refer to Section 7, 5. "MAGNETIC ENCODER OUTPUT SIGNAL" when checking the output signals of the encoder.)	Change the sensor or the gear.
		The control board is faulty.	Make sure that all the items above are correct.	Change the control board.
25	Cycle overflow error	The control board is faulty.	—	Change the control board.
26	Watchdog error			
27	Analog-to-degital access alarm			
28	Master cpu error			
29	Slave cpu error			
30	Speed deviation too large	Operation in overloaded condition	—	Check the cutting conditions and cutting tools.
		Disconnection or loose connection of motor power cables	Check the motor power cables.	Connect the motor power cables correctly.
		Motor signal cables are faulty. (loose connection, miswiring, etc.)	Check the motor signal cables.	Connect the motor signal cables correctly.
		The power unit is faulty.	—	Change the power unit.
		The control board is faulty.	Make sure that all the items above are correct.	Change the control board.
		Magnetic contactor for winding changeover or magnetic contactor drive relay is faulty.	Refer to the maintenance manual for the machine.	Change the magnetic contactor for changing winding or magnetic contactor drive relay.

Alarm No.	Alarm Name	Failure Factor	Check	Measures
31	Coil switch	Magnetic contactor and/or magnetic contactor drive relay for winding changeover is faulty.	Refer to the maintenance manual for the machine.	Change magnetic contactor and/or magnetic contactor drive relay.
		The control signal cable is faulty. (disconnection or loose connection) (magnetic contactor operation signal, confirmation signal)	Check the cables.	Connect the cables properly.
		The control board is faulty.	Make sure that all the items above are correct.	Change the control board.
32	RAM error	The control board is faulty.	—	Change the control board.
33	High speed motor parameter setting	There is an error in the motor data in the PBU data file.	Check the PBU data file.	Correct the data.
34	Power supply voltage flutter over	Voltage fluctuation is large due to high power source impedance.	Check the power supply voltage fluctuation ratio according the procedure explained in Section 7, 4. "CALCULATING SOURCE VOLTAGE MOMENTARY FLUCTUATION RATIO".	Change the power supply with the one having a lower impedance.
35	Master CPU down	The control board is faulty.	—	Change the control board.

3-2-6. Long Acceleration and Deceleration Time

Table 3-10

Failure Factor	Check	Measures
Operation in overloaded condition	—	Reduce load.
Torque limit command is provided.	Check the indication of TLMC.	Clear the torque limit command.
Source voltage is high.	Refer to Table 3-3.	Refer to Table 3-3.
Broken or loose connection of motor power cables	Check the motor power cables.	Connect the motor power cables correctly.
Fuses in gate circuits are blown.	Check the fuses in gate circuits. (Refer to 2-1. "Inspection and Changing Procedure for Fuses".)	Change blown fuse.
IBGT module is faulty.	Check the IBGT module. Refer to Section 6, 3-1. "IBGT Module Inspection Procedure".	Change the IGBT module.
Control board is faulty.	Make sure that all the items above are correct.	Change the control board.
Power source impedance is high.	Check fluctuation of power supply voltage during deceleration. Refer to Section 7, 4. "CALCULATING SOURCE VOLTAGE MOMENTARY FLUCTUATION RATIO" for the procedure to check the power supply voltage fluctuation ratio.	Change the power supply with the one having a lower impedance.

3-2-7. Excessive Vibration and Noise while the Motor is Rotating

Table 3-11

Failure Factor	Check	Measures
Motor installation is loose; coupling with the spindle is loose.	Check motor installation or motor coupling to spindle.	Install the motor correctly.
VACIII drive unit or connection of cables is faulty.	Refer to Table 3-7.	Refer to Table 3-7.
VAC motor is faulty.	Make sure that all the items above are correct.	Change the motor.

Note: To determine the cause of the problem, coast the VAC motor. For this, following the procedure below.

(1) Start the VAC motor.

(2) Remove the optical fiber connector from the VACIII drive unit.

(3) The "communication error" occurs and the VAC motor runs freely.

4. RECOVERY FROM FAILURE STATUS

When LED's indicate the faulty operation status, it is necessary to remove the cause of failure first and then reset the alarm state to recover the operations of the VAC drive unit.

Spindle servo unit alarms are classified into the following four levels according to the nature of alarm and the way to prestore the operation.

Table 3-12

Alarm Level	How to Reset	Nature of Alarm
Level 1a	Set the three-phase breaker to the "OFF" position and then set it to the "ON" position again.	VAC hardware must be initialized, (for example exception alarm)
Level 1b	Turn off the power to the NC once and then turn it on again at the machine operation panel.	Parameters must be initialized.
Level 2	Reset the NC at the machine operation panel.	Alarm which might be caused by cutting conditions. (for example DIFF OVER alarm)
Level 3	Reset the NC at the machine operation panel.	Overload-related alarms

SECTION 4 ADJUSTMENT AT INSTALLATION

1. ADJUSTMENT AT SYSTEM START-UP

For the VACIII drive unit, all control parameters are set with the software through the communication with the NC unit using optical fiber cable. Therefore, it is not necessary to set or adjust the parameters manually during installation.

2. SETTING AND ADJUSTMENT OF CONTROL PARAMETERS

The parameters used for the control by the VACIII drive unit are stored in the software of the NC unit as the VAC PBU data file.

To use the VACIII drive unit for a new model of machine tool, it is necessary to set or change the corresponding parameter data in the VAC PBU data file.

SECTION 5 SETTING ON THE CONTROL BOARD

For the arrangement of devices on the control board, refer to Figs. 1-3 to 1-5.

Before turning on the power, check the following setting.

(1) All switches in SW1 and SW2 are OFF.

(2) All variable resistors are set to "0".

(3) ROM version is "VACA200A" of above.

Note: For details of upgrade information concerning ROM version, contact your local OKUMA representatives.

SECTION 6 CHANGING THE CONTROL BOARD AND UNITS

1. CHANGING THE POWER UNIT

⚠WARNING : Just after turning off the power to the VACIII drive unit, high voltage remains applied to the components inside the unit and careless touching of these components will cause electric shock.

With the VACIII-D6 unit, you are allowed to inspect or repair the power unit after an elapse of 1 minute. With the VACIII-D11 or -D22 unit, you allowed to inspect or repair the power unit after making sure that the main circuit charged indicating LED on the control board has been turned off.

The procedure used for changing the power unit is indicated in Table 6-1.

Table 6-1 Procedure to Change the Power Supply Unit

Process	Contents	Reference Item
1	Turn off the power supply.	
2	Remove the power cables and motor power cables.	
3	Loosen the connector fixing screws and remove connectors CN1 to CN3 (CN1, 11 and 12 in the case of VACIII-D6 unit). Remove the connector for the optical fiber cable.	
4	Loosen screws and detach the cover.	
5	Remove the control board.	Table 6-3
6	Install a new power unit.	
7	Run the VACIII drive unit.	Table 6-2
8	Install the cover and clamp it with screws.	

After replacing parts or units, make a test run according to the procedure in Table 6-2.

Table 6-2 Procedure to Change the Power Supply Unit

Process	Contents
1	Confirm that the switch settings, variable resistor settings, and ROM version are all correct, referring to Section 5. "SETTING ON THE CONTROL BOARD".
2	Turn on the power and confirm that the green LED "POWER" lights. Confirm that the cooling fan of the VACIII drive unit and the VAC motor rotate.
3	Check if the 7-segment LED's indicate 01 immediately after turning on the main breaker, and the indication turns to 02 when the NC starts up by operation power supply.
4	Input the rotation command to check the motor rotation both in the forward and reverse directions.
5	Check the operations over the entire speed range and in the position control mode.

2. CONTROL BOARD CHANGING PROCEDURE

⚠WARNING : Just after turning off the power to the VACIII drive unit, high voltage remains applied to the components inside the unit and careless touching of these components will cause electric shock.

With the VACIII-D6 unit, you are allowed to change the control board after an elapse of 1 minute. With the VACIII-D11 or -D22 unit, you allowed to change the control board after making sure that the main circuit charged indicating LED on the control board has been turned off.

The procedure used for changing the control board is indicated in Table 6-3.

Table 6-3 Procedure to Change the Control Board

Process	Contents	Reference Item
1	Turn off the power supply.	
2	Loosen screws and detach the cover.	
3	Remove the control board.	Table 6-4
4	Install the new control board.	Table 6-5
5	Run the VACIII drive unit.	Table 6-2
6	Install the cover and secure it with screws.	

The procedure to remove an mount the control board is indicated in Tables 6-4 and 6-5.

For the arrangement of the connectors, refer to Figs. 1-2 to 1-5.

Table 6-4 Procedure to Change the Power Unit

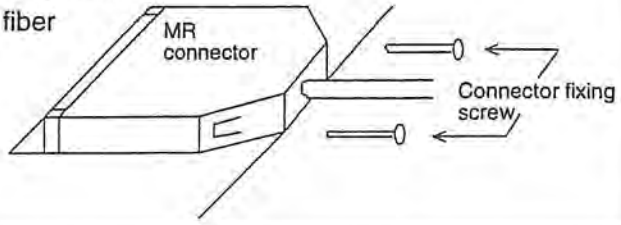
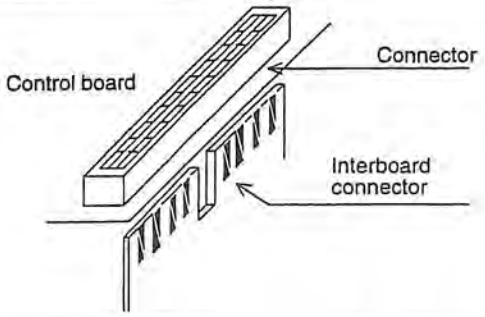
Process	Contents
1	Loosen connector fixing screws and remove connector CN1 to CN3 (CN1, 11 and 12 in the case of VACIII-D6 unit). Remove the connector for the optical fiber cable. 
2	Remove the M4 screws which fix the control board.
3	Pull the control board while holding its upper and lower parts and remove it from the power unit.

Table 6-5 Procedure to Change the Power Unit

Process	Contents
1	Insert the interboard connector in the connectors on the control board. 
2	Fix the control board with the M4 screws.
3	Connect the connectors CN1 to CN3 (CN1, 11 and 12 in the case of VACIII-D6 unit) and clamp them firmly with connector fixing screws.
4	Check the ROM, switch settings and variable resistor settings in reference to the Section 5. "SETTING ON THE CONTROL BOARD".

3. CHANGING THE SEMICONDUCTOR DEVICES

CAUTION : After the completion of inspection or change, set the leads and bus bars to the original position correctly and tighten the screws firmly. If even one screw is not used or not tightened, the unit might be damaged or fail to function correctly.

Take care so that you do not lose a screw. The screw left inside the unit might be a cause of short circuit.

3-1. Inspecting and Changing the IGBT

(1) Remove the power and the motor cables.

(2) Remove the control board.

(3) Remove the power board.

(4) Measure resistance between terminals using a multimeter.

Terminal locations and internal equivalent circuit on the IBGT module are shown in Figs. 6-6 to 6-7. For the judgment criteria, see Table 6-6.

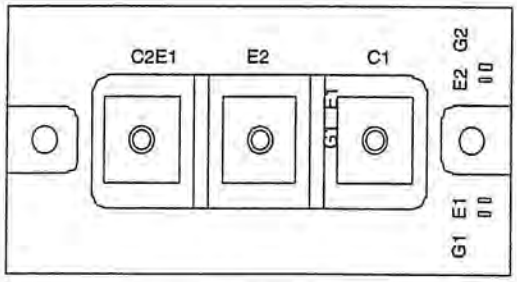
(5) If the measured resistance value is abnormal, change the IGBT module.

For the procedure to change the IGBT module, refer to 3-3 "Changing the Semiconductor Devices in the Main Circuit".

(6) Install the power board.

Always make sure that the power board is secured with screws firmly.

(7) After completion of inspection and maintenance, install the control board, clamp it in place with screws and connect it with the motor and the power cables.



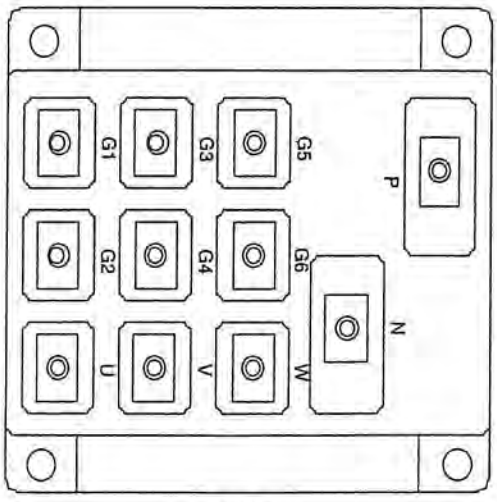


Fig. 6-6 IGBT Module Terminal Arrangement

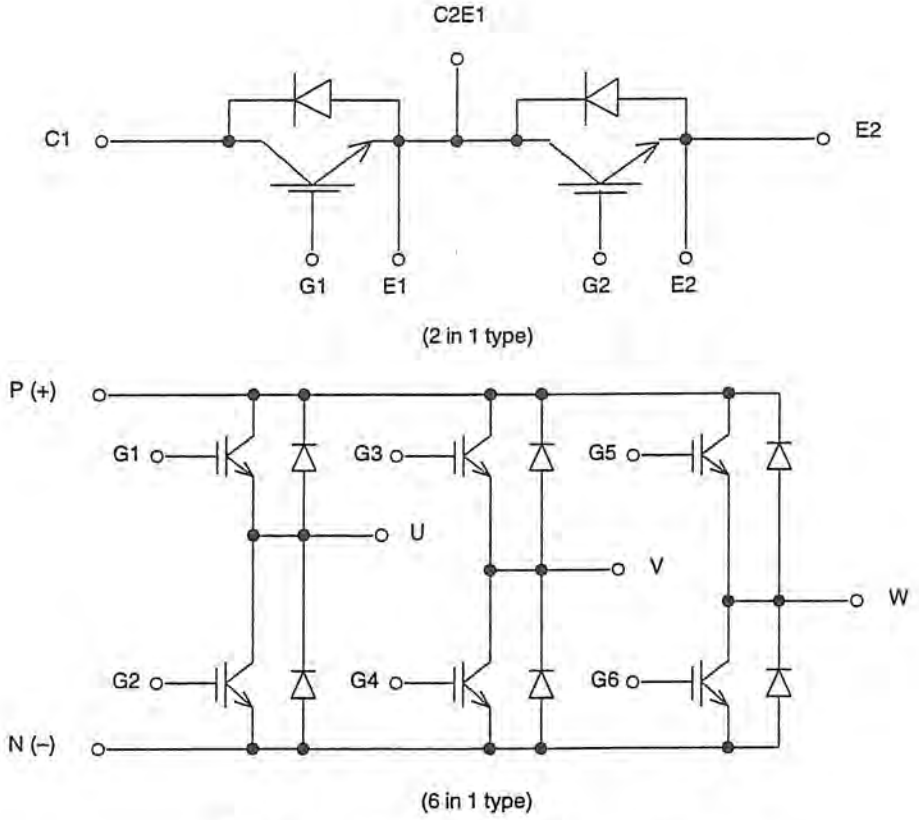


Fig. 6-7 Equivalent Circuit of IGBT Module

Table 6-6 Judgement Criteria (Multimeter Range Setting: × 10)

IGBT Terminals		Normal	Abnormal
Multimeter Terminal (+) Side	Multimeter Terminal (–) Side		
C	E	Several tens to several hundreds of ohms	0 Ω, ∞
E	C	∞ (Note)	Several hundreds of ohms or less
C	G	∞	Several kilo-ohms or less
G	C	∞	Several kilo-ohms or less
G	E	∞	Several kilo-ohms or less
E	G	∞	Several kilo-ohms or less

Note: To obtain correct measurements, make short-circuit between terminals G and E.

3-2. Inspecting and Changing the Diode Module

(1) Remove the control board and power board.

(2) Measure the resistance between the terminals of diode module using a multimeter.

(3) If the measured resistance value is abnormal, change the diode module.

(4) Install the power board and the control board.

Always make sure that the power board and the control board are secured with screws firmly.

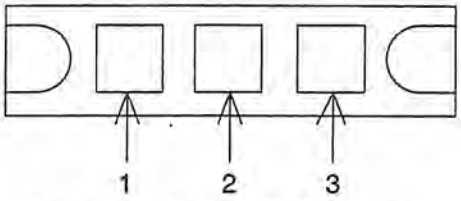


Fig. 6-8 Diode Module Terminal Arrangement

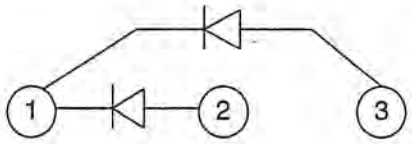


Fig. 6-9 Equivalent Circuit of Diode Module

Table 6-7 Judgement Criteria (Multimeter Range Setting: × 10)

Transistor Terminals		Normal	Abnormal
Multimeter Terminal (+) Side	Multimeter Terminal (–) Side		
1	2	Several tens to several hundreds of ohms	∞
1	3	Several tens to several hundreds of ohms	∞
2	1	∞	Several hundreds of ohms or less
3	1	∞	Several hundreds of ohms or less

3-3. Changing the Semiconductor Devices in the Main Circuit

If a semiconductor device in the main circuit is found defective in the inspection explained above, use the procedure indicated in Table 6-8 to change the defective device.

Table 6-8

Process	Contents	Remarks
1	Remove all the screws and gate connectors from the power board to dismount the power board from the power unit.	
2	Remove the module clamping screws and gate wires (only for D11 and D22) to detach the module.	
3	Coat silicone grease to a new module.	This is to improve contacting conditions between the module and the installation surface thus to provide better cooling effect.
4	Install a new module and securely tighten the screws.	Pay attention to module installation orientation.
5	Connect the gate wires to the new module. (only for D11 and D22)	
6	Install the power board by securely attaching screws and connectors without omission.	Ensure that all the screws are tightened.

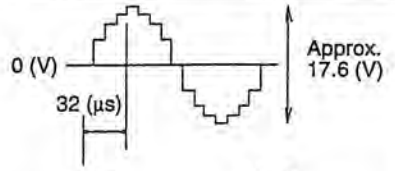
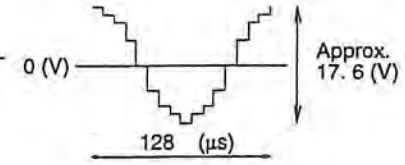
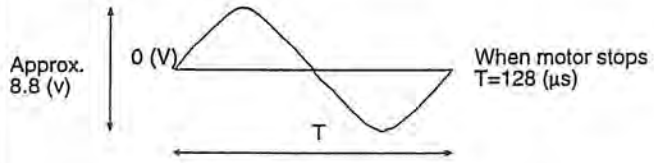
: The IGBT uses metal oxide semiconductor (MOS) elements. Be careful not to get electrostatic shock.

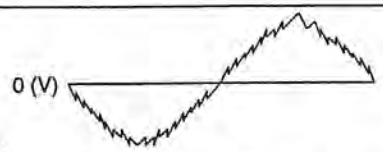
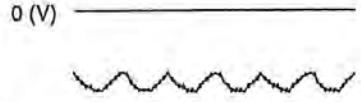
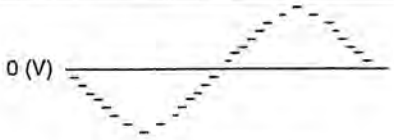
Do not remove the static electricity preventive mat before connecting gate wires.

SECTION 7 APPENDIX

1. CHECK TERMINALS

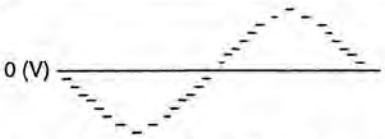
For the layout of the check terminals, refer to Figs. 1-3 to 1-5.

Check Terminal	Probe Common Terminal	Contents	Remarks
GND	–	Separated from the regenerative control circuit, the input/output signal circuit, and the gate circuit.	
S1	GND	Resolver excitation signal Sine wave 	
S2	GND	Resolver excitation signal Cosine wave 	
R1	GND	Resolver feedback signal  - Phase difference to the excitation signal changes as the motor rotates. - Frequency f (Hz) varies as indicated below according to the motor speed N min^{-1} {rpm}. $f = 1/T = \frac{1}{128 \times 10^{-6}} \pm \frac{8N}{60}$ (+ in the forward rotation and – in the reverse rotation)	
VEL	GND	Velocity monitor The motor speed min^{-1} {rpm} is indicated. ±10 [V] at the maximum motor speed	

Check Terminal	Probe Common Terminal	Contents	Remarks
TQ	GND	Torque monitor The motor output torque is indicated. ±10 [V] at the maximum motor output torque at each speed	
IS	GND	Inverter circuit current detection	The IOCS alarm occurs at higher than approx. 2.75 V (1.4 V for D6).
IR	GND	Regenerative circuit current detection	The IOCS alarm occurs at higher than approx. 1.7 V (0.85 V for D6).
IU	GND	U-phase current feedback signal  Cycle and amplitude changes depending on operation state.	
IV	GND	V-phase current feedback signal	
IM	GND	Current feedback three-phase full wave rectifying signal - Cycle and amplitude changes depending on operation state. - With the VACIII control board, the current feedback signal is rectified to negative voltage.  Cycle and amplitude changes depending on operation state.	The IOCR alarm occurs at lower than –6.6 V.
IUC	GND	U-phase current command signal  Cycle and amplitude changes depending on operation state.	
IVC	GND	V-phase current command signal	

Check Terminal	Probe Common Terminal	Contents	Remarks
IDU	GND	U-phase current amplifie signal	
IDV	GND	V-phase current amplifie signal	
EUC	GND	U-phase induced voltage command signal	
EVC	GND	V-phase induced voltage command signal	
MON	GND	Internl control status monitor	
+5 V	GND	Control circuit power voltage	
+15 V	GND	Control circuit power voltage	
–15 V	GND	Control circuit power voltage	
COM	–	Grounding in regenerative control circuit When checking the waveform in the regenerative circuit, use an insulated oscilloscope. Be careful that the COM terminal is not short-circuited with other circuit, for example with the GND terminal, in the oscilloscope.	
+V	COM	Regenerative control circuit power voltage	
A B Z	GND GND GND	Refer to Section 7, 5. "MAGNETIC ENCODER OUTPUT SIGNAL".	

Cycle and amplitude changes depending on operation state.



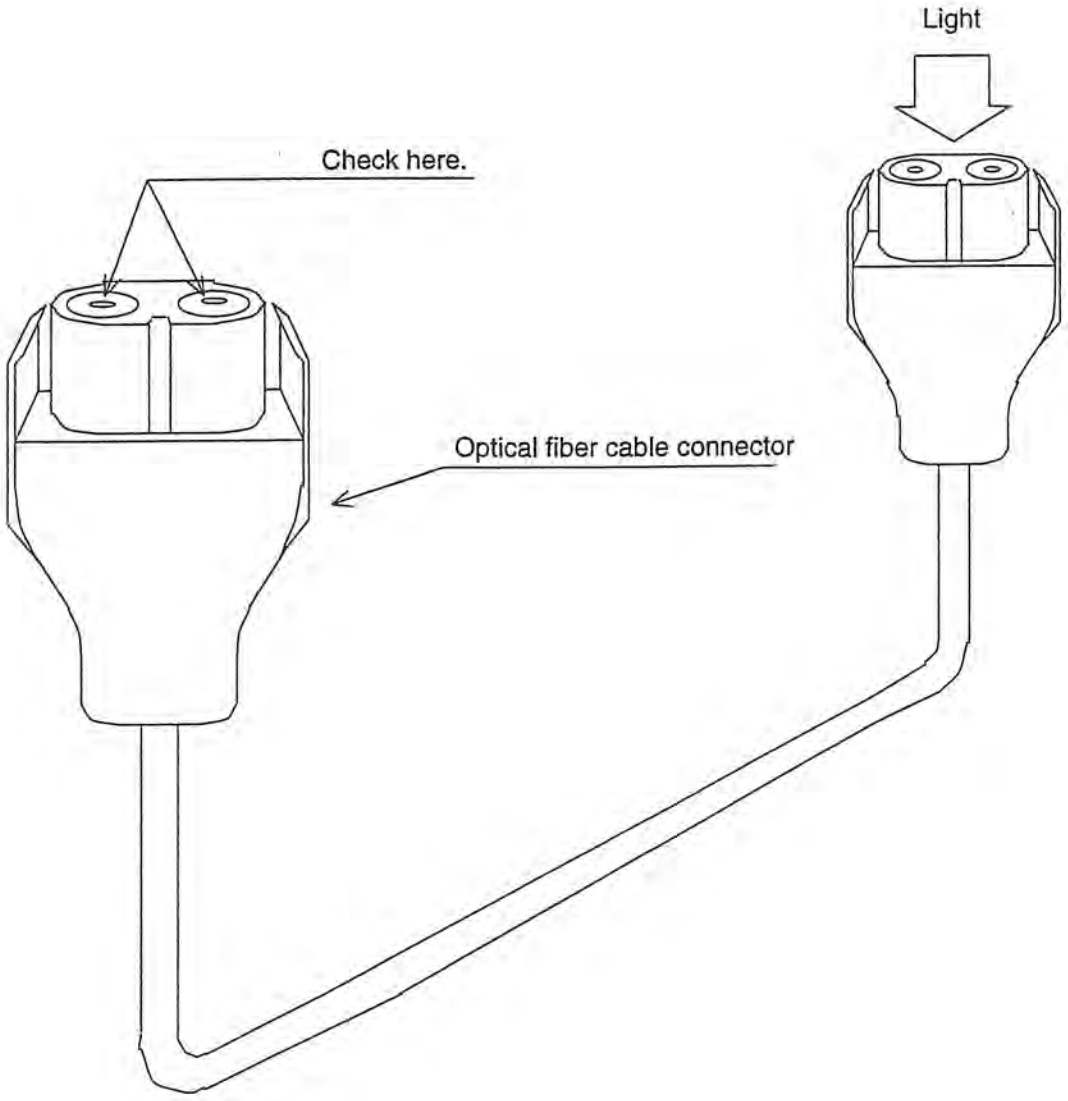
Cycle and amplitude changes depending on the motor speed.

⚠WARNING : When checking the waveform in the regenerative circuit, use an insulated oscilloscope.
Be careful that the COM terminal is not short-circuited with other circuit, for example with the GND terminal, in the oscilloscope.

2. INSPECTION OF OPTICAL FIBER CABLE

Throw light on one of the optical fiber cable connectors and check if the other connector lights up.

If there is difference in brightness between right and left, the cable is faulty.



3. CONNECTOR PIN CONFIGURATION

Pin configuration of the connectors connecting the VACIII drive unit to the VAC motor and the I/O unit is indicated below.

(1) Connection to the I/O Unit

Connectors used for the connection with the I/O unit are indicated below:

Unit Size	Connector Name
D6	CN12
D11, D22	CN1

Pin Configuration

				Pin No.	Signal Name
14		8	MRDY-COM	1	
15	MRDY	9		2	HMSC1
16		10	RLMSC-COM	3	HMSC2
17	RLMSC	11	RHMSC-COM	4	LMSC1
18	RHMSC	12		5	LMSC2
19		13		6	
20				7	

Note: Specifications for connection

Optical fiber cable : C200-250-AL12 (Hitachi)

Optical fiber connector : CA9003 (Hitachi)

MRDY, winding changeover signal wires : 0.5 mm^2 wire

Connector type : MRP-20F01

(2) Connection to the Magnetic Encoder

Connect the magnetic encoder and the pulse generator to detect the spindle angular position.

Connectors used for the connection with the magnetic encoder are indicated below:

Unit Size	Connector Name
D6	CN1
D11, D22	CN2

Pin Configuration

				Pin No.	Signal Name
14	DZ			1	GND (FG)
15	DB	8	GND	2	+5 V
16	DA	9	GND	3	GND
17	AZ	10	GND	4	GND
18	AB	11	AZ-RT	5	+12 V
19	AA	12	AB-RT	6	+12 V
20		13	AA-RT	7	

Note: Specifications for connection

Connector type : MRP-20F01

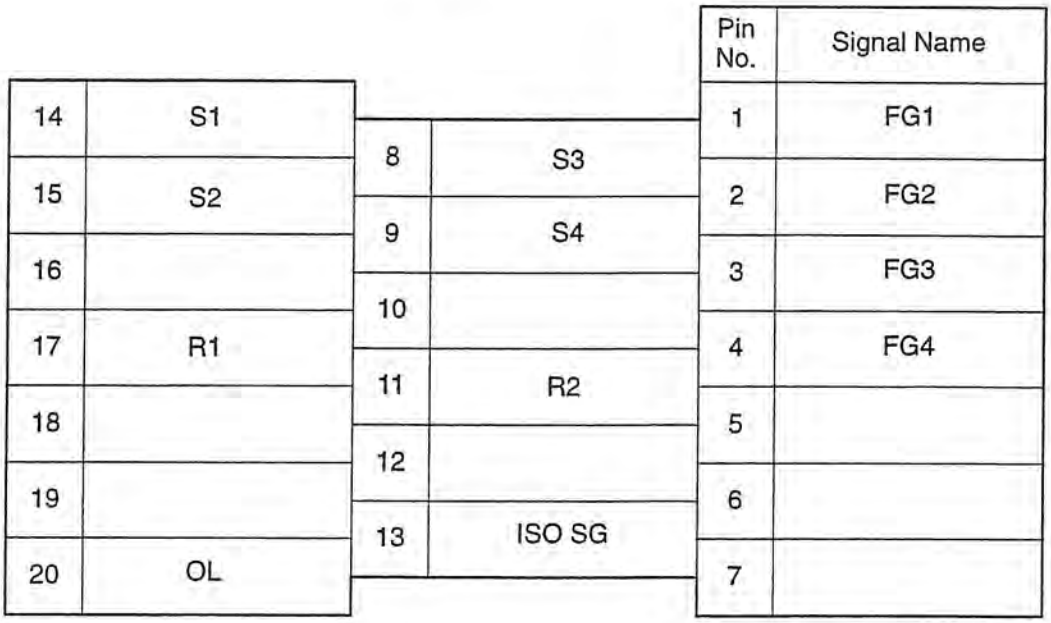
Signal wire : 0.2 mm^2 4-pair twisted-pair shield wire

(3) Connection to the Resolver

Connectors used for the connection with the resolver are indicated below:

Unit Size	Connector Name
D6	CN11
D11, D22	CN3

Pin Configuration



Note: Specifications for connection

Connector type : MRP-20F01

Signal wire : 0.2 mm^2 4-pair twisted-pair shield wire

4. CALCULATING SOURCE VOLTAGE MOMENTARY FLUCTUATION RATIO

Check the source voltage momentary fluctuation ratio following the procedure indicated below.

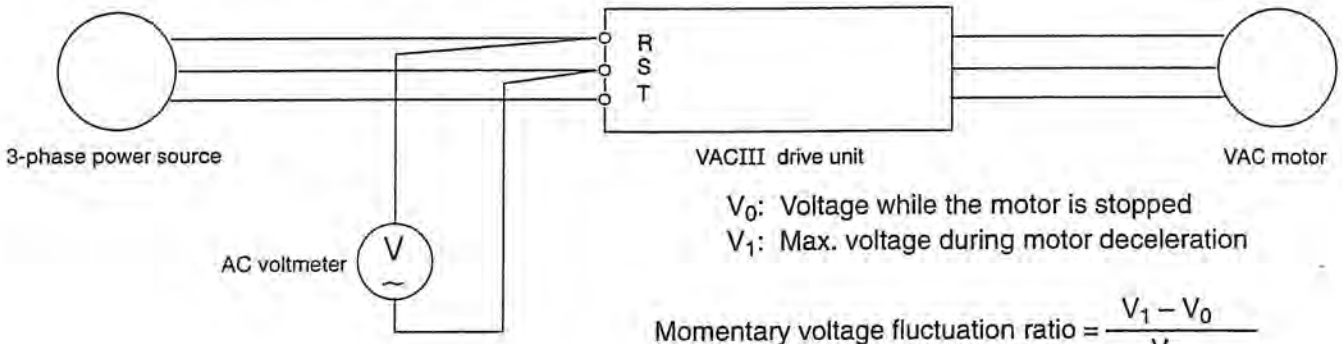
Allowable momentary fluctuation ratio:

200V AC : 15%

220V AC : 6%

If the measured momentary fluctuation ratio is greater than the allowable limit, it is necessary to use the power source with smaller impedance.

Calculating momentary voltage fluctuation ratio:



V_0: Voltage while the motor is stopped

V_1: Max. voltage during motor deceleration

$$\text{Momentary voltage fluctuation ratio} = \frac{V_1 - V_0}{V_0}$$

(1) As indicated in the illustration above, connect the AC voltmeter to the power supply terminals at the VACIII drive unit.

(2) Measure the voltage while the drive motor is stopped. Take this value as "V_0".

(3) Measure the voltage while the drive motor is decelerating. Take this value as "V_1".

(4) Calculate the momentary voltage fluctuation ratio using the following formula.

Momentary voltage fluctuation ratio = $(V_1 - V_0)/V_0$

Note 1: Since a digital AC voltmeter has slow response, momentary voltage fluctuation ratio obtained using the voltage measured with the digital AC voltmeter is lower than the actual value. To obtain the precise value, it is recommended to use an analog voltmeter.

Note 2: Voltage "V_1" cannot be measured accurately if motor decelerating time is short. Therefore, it is recommended to start deceleration from as high spindle speed as possible.

Note 3: If the "excessive voltage fluctuation ratio" alarm is generated due to power source impedance higher than the allowable limit, output is restricted by the VACIII drive unit. Therefore, the momentary voltage fluctuation ratio calculated under such situation is not reliable.

5. MAGNETIC ENCODER OUTPUT SIGNAL

(1) Adjusting the Magnetic Encoder Gap

If the gap between the magnetic encoder and the detecting gear is too large, A-, B-, and Z-phase signal voltage will become lower. Check the output signal of the magnetic encoder using the procedure indicated below.

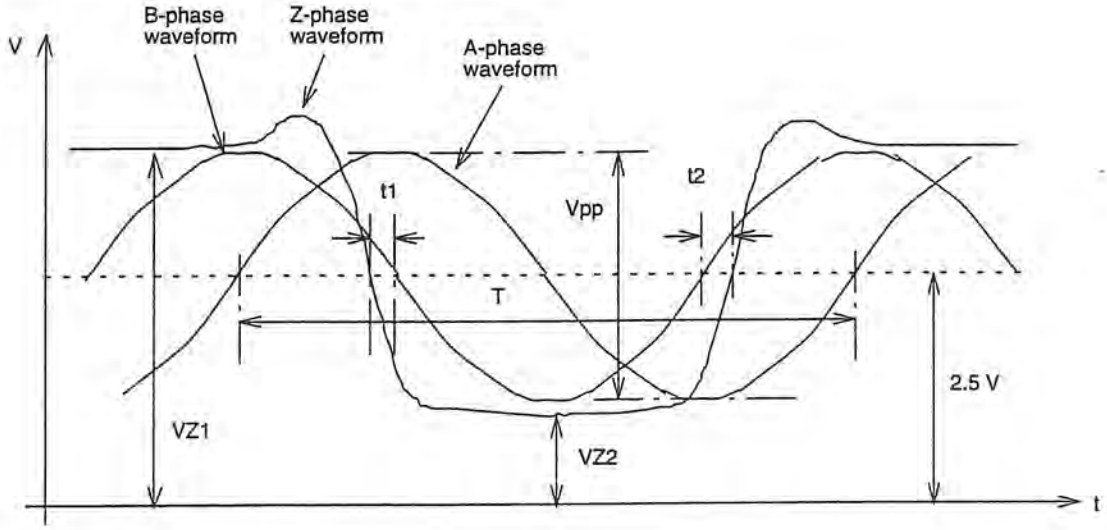
a) Procedure

Observe the voltage waveform at the check terminals on the VACIII control board while rotating the spindle.

A-phase: A terminal - GND terminal

B-phase: B terminal - GND terminal

Z-phase: Z terminal - GND terminal



b) Judgment

Item		Criteria
Vpp:	Amplitude of A-/B-phase voltage	2.3 to 4.2 V
VZ1:	Amplitude of Z-phase voltage	Higher than 3.7 V
VZ2:	Amplitude of Z-phase voltage	Lower than 2.2 V
t1, t2:	Phase of Z-phase	0.1T to 0.4T (T: 1 cycle of A-/B-phase)

If VZ1, VZ2, t1, and/or t2 value is not correct although Vpp value is correct, gap adjustment will be improper. Or, magnetic encoder sensor or detecting gear might be faulty.

(2) Run-out of Detecting Gear

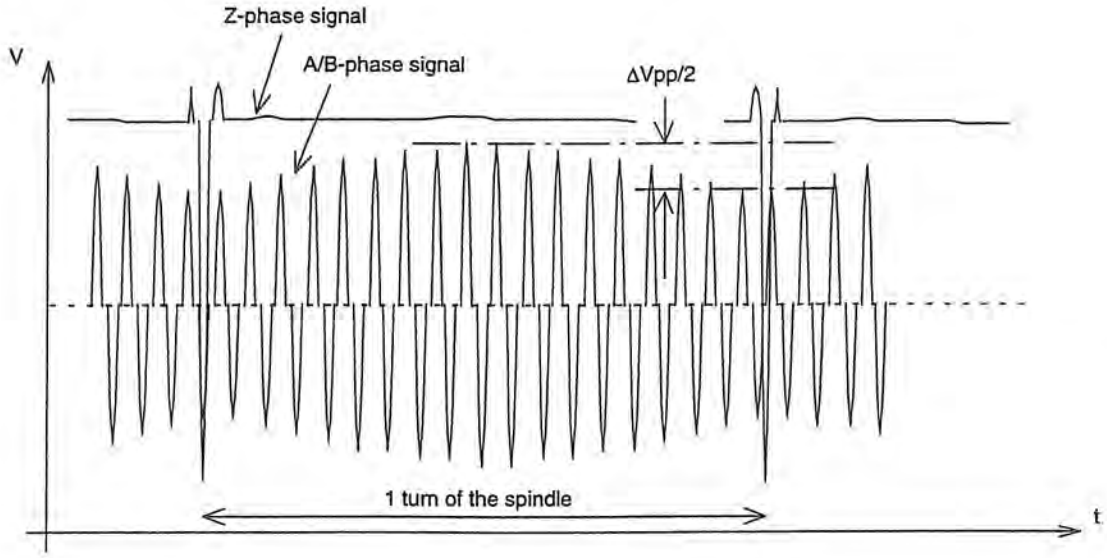
If the detecting gear is not mounted correctly at the center, amplitude of the magnetic encoder output signal will fluctuate as the spindle rotates. Check the output signal of the magnetic encoder using the procedure indicated below.

a) Procedure

Observe the voltage waveform at the check terminals on the VACIII control board while rotating the spindle.

A-phase: A terminal - GND terminal

B-phase: B terminal - GND terminal

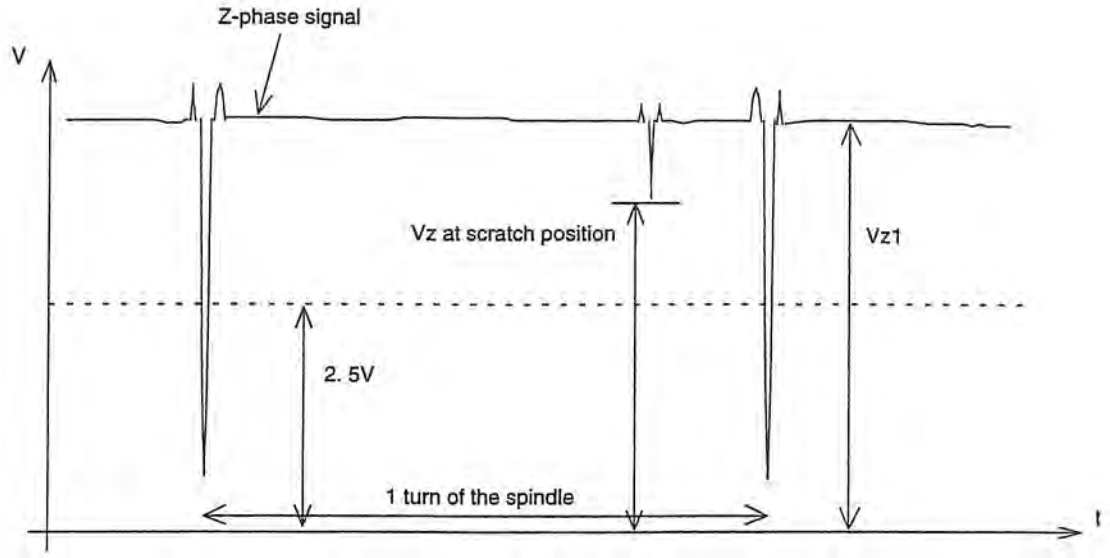


b) Judgment

	Criteria
Built-in motor, pick-off specification	200 mV max.
C-axis control specification	100 mV max.
Synchronized tapping specification (without built-in motor)	500 mV max.

(3) Scratch on the Detecting Gear

If there is a scratch on the detecting gear, a signal is generated at a position which is not a correct Z-phase position. Check the Z-phase signal referring to the diagram below.



a) Judgment

	Criteria
Criteria: Vz at scratch position	Higher than 3.5 V

(4) Noise in Magnetic Encoder Signals

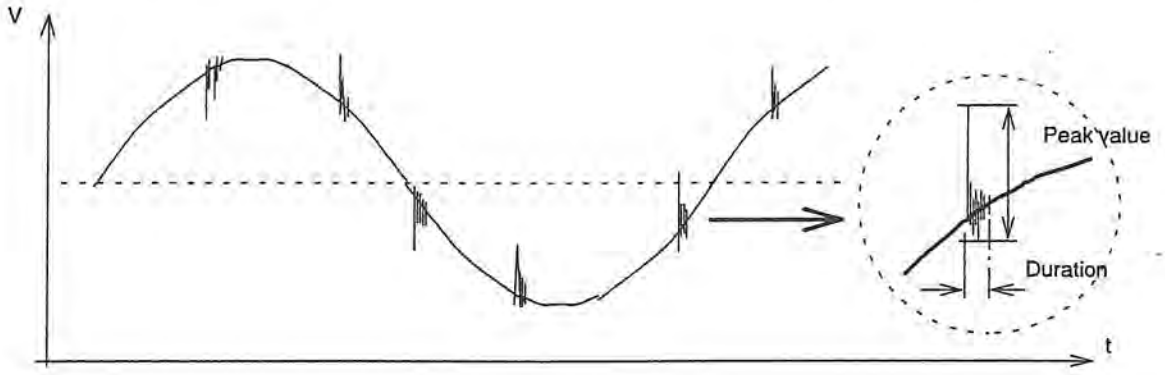
Noise due to motor current switching operation is apt to overlap magnetic encoder signals and observation of the magnetic encoder signal will show the noise as indicated below. If excessively large noise is observed, check the following:

- Is the shield of the magnetic encoder cable connected correctly?
- Is there a noise source such as a magnetic contactor located near the magnetic encoder?

Noise of the following specification will not give adverse affect on correct operation.

Peak value : 1 to 1.5 V

Duration : 2μs



REVISION HISTORY

Manual Name : SPINDLE SERVO UNIT
MAINTENANCE MANUAL

Manual No. : 4018-E
(EES4-001-O∗∗)

Edition	Date	Revision
(01)	January '95	First edition